1999 Annual Report

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Alberta
Agriculture, Food and
Rural Development

Crop Diversification Centre South
Brooks, Alberta
Crop Diversification Centre North
Edmonton, Alberta

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Introduction

R.J. Howard and S.F. Blade

The Crop Diversification Centres North and South (CDCN and CDCS) are research and development units of the Plant Industry Division of Alberta Agriculture, Food and Rural Development (AAFRD). They focus on applied research and technology transfer in support of the horticulture, special crop and forage industries in Alberta. The Centres' mandate of crop diversification and industry development is achieved through close partnerships with commodity organizations, grower groups, agribusinesses, university, federal and private sector researchers, and individual producers and processors.

This annual report covers the activities of staff in the New Crop Development, Horticulture, Forage, and Pest Prevention and Management Units located at CDCN and CDCS, as well as for the Food Science Program at CDCS, which is administered by the Food Processing Development Centre at Leduc. Only brief summaries of projects and trials carried out in 1999 are reported here. Please refer to the Publications and Presentations section of this report for citations of more detailed sources of information.

The Horticulture Unit is responsible for programs dealing with potato, fruit, greenhouse, nursery and vegetable crops. The Unit also manages programs in plant pathology, entomology, micropropagation and market development, with specific responsibilities for the Alberta Vegetable Sales Act and Alberta Farmers' Market Program. The Unit provides administrative and farm support to staff in the New Crop Development, Forage, and Pest Prevention and Management Units at CDC South's headquarters farm at Brooks and at its substations in southern Alberta, as well as to the Food Science Program based at Brooks.

The New Crop Development Unit is responsible for special crop research and development at CDCN and CDCS, as well as for plant pathology, weed science, post-harvest technology, and soil and water agronomy support to the Horticulture and Forage Units at CDCS. The Unit also includes an Apiculture Program based at CDCN, with a satellite office in Falher, which provides extension and regulatory services to the commercial beekeeping industry throughout Alberta.

At CDCS, Forage Unit staff are involved in research and industry development related to the grass seed production, while staff in the Pest Prevention and Management Unit oversee the province's Dutch Elm Disease Prevention Program. The Food Science Program serves the research and extension needs of new and established food processors in southern Alberta, and it also provides valuable food processing and quality evaluation services to several horticulture and special crop research programs at the Centre.

Directors' Report

R.J. Howard and S.F. Blade

Alberta's horticultural, special crop and forage industries continued to expand and diversify in 1999, placing heavy demands on CDCN and CDCS staff for research and extension services. These challenges were met through a number of new and ongoing projects, most of which were in partnership with industry and other research institutions. The level of funding received from producer and commodity organizations, agribusinesses and federal/provincial granting agencies this past year exceeded $0.5 million at the two Centres. More and more industry organizations are establishing research committees and monetary check-offs as a means of prioritizing and investing in new technology development. CDCS and CDCN staff have been successful in tapping these external funding sources in order to conduct new projects requested by industry.

A major departmental reorganization occurred in 1999 which saw the management of the Food Science Program at CDCS transferred to the Food Processing Development Centre, Leduc; the Forage Program at CDCS transferred to the Animal Industry Division; and a new Plant Industry Division Director, Alan Hall, appointed to replace Don Macyk. Clive Schaupmeyer, the long-time Potato Agronomist at CDCS, was transferred to Taber in July to better serve the extension needs of the rapidly expanding potato processing industry in that area.

Two significant staff retirements occurred at CDCS in 1999. Tom Krahn, the former Director and Leader of the Horticulture/Apiculture Unit, retired on March 31st after 32 years of service to Alberta Agriculture, Food and Rural Development. His departure was followed by Rudy Esau, Weed Scientist, who retired on June 15th after 23 years in this position. Both occasions we marked by retirement parties that were attended by friends, family and former colleagues. In addition, Bob Park, Special Crops Agronomist with the New Crop Development Unit at Lacombe, retired on October 31st. Bob's achievements in his 33+ years with the department were recognized at a party with staff from the Field Crops Development Centre in December.

The Alberta Horticultural Congress, which was held in Edmonton from November 11-13, attracted over 2500 delegates to the presentation sessions and trade show. Several Centre staff assisted served on the organizing committee and acted as resource speakers and facilitators. The Alberta New Crops Network officially came into being in December. About ten organizations representing minor crops, organic producers, AAFRD and Olds College formed this umbrella group to provide identity, marketing support, education and networking opportunities for its members with the goal of further developing the new crops industry in the province. CDCS and CDCN staff were also actively involved with several commodity groups, including the Potato Growers of Alberta, Alberta Pulse Growers Commission, Landscape Alberta Nursery Trades Association, Alberta Greenhouse Growers Association, Alberta Market Gardeners' Association, Fruit Growers Society of Alberta, Alberta Vegetable Growers (Processing), as well as with the Alberta Agricultural Research Institute, the Canadian Horticultural Council, and several AAFRD product teams and committees. Staff also organized and participated in numerous information sessions, workshops, field days and tours during the year.

This Annual Report is a summary of ongoing research and extension programs at CDCN and CDCS. It represents the dedicated work of AAFRD staff who continue to play a major role in the development of the agricultural industry in Alberta and beyond. Additional information on any program area, including detailed research reports, is available upon request.

Food Processing

Food Science & Technology Program

D.R. Driedger, L.R.J. Dowdell, C. Turner and M. Hansen

In April 1999, administration of the Food Science and Technology Program was transferred to the Food Processing Development Centre in Leduc. The program continues to operate out of the Crop Diversification Centre South (CDCS), Brooks with the objective of assisting Alberta companies in their efforts to develop, manufacture and ultimately market more value-added goods from agriculture commodities. In addition, the program supports crop production research programs at CDCS by carrying out chemical analyses and sensory evaluations on new and existing cultivars/varieties of fruits, vegetables, potatoes, pulses, herbs and spices.

Research Projects

Native fruit quality

A study involving the evaluation of organoleptic characteristics of four saskatoon berry cultivars for commercial processing was extended for a third year. The most widely grown cultivars, Smoky, Northline, Honeywood and Thiessen, were selected for this study. The objective was to identify cultivars best suited for use as jam, jelly, syrup, and pie filling. Attributes such as appearance, taste, texture, and overall acceptability were assessed for each cultivar. Final sensory testing is in progress. The project was jointly funded by the Alberta Agriculture Research Institute, Fruit Growers Society of Alberta, Saskatchewan Fruit Growers Association, and the Prairie Fruit Growers Association of Manitoba.

Potato quality evaluation

In collaboration with Dr. Dermot Lynch, potato breeder at the Agriculture and Agri-Food Canada Research Centre, Lethbridge, the commercial processing quality of samples from the Potato Consortium Study and the Processing Trial Research Project were evaluated. Samples were evaluated for french fry, chipping, boiling and baking quality. Sugar analysis was also performed on the Processing Trial samples. Results were forwarded to Dr. Lynch.

Service to other programs at CDCS

Essential oils extracted from herbs and spices grown by the special crops program at CDCS were analysed for flavor components by gas chromatography. Crops tested included basil, sage, hyssop, yarrow, peppermint, and spearmint. Results will be used in selecting cultivars for commercial production and processing.

In support of the Prairie Potato Breeding Program, potato cultivars and selections were processed and evaluated for their french fry, boiling, baking and chipping quality. Total glycoalkaloid content of selected cultivars was also determined. The results will be used in selecting cultivars for commercial production and processing.

Technology Transfer Services

Testing services were provided to several companies, including color evaluation of peas, sugar analysis in carrots, and water activity and pH of pepperoni. A new program leader, D.R. Driedger, was hired in October.

Forage Unit

Grass Seed & Forage Crops Program

H. Najda and A. Kruger

The grass seed and forage crops program at the Crop Diversification Centre South (CDCS), Brooks is part of the Forage Unit administered through the Lacombe Research Centre. The program conducts agronomic and adaptability research to provide up-to-date information on grass seed production and traditional forage crops. New crop species and varieties are submitted for experimental purposes by universities, research agencies and private industry in Canada, the United States and Europe.

Research involving more than 100 irrigated and dryland trials were conducted at various locations in southern Alberta including sites at CDCS, the CDCS substation at Bow Island and Standard, Alberta.

Several trials were conducted in cooperation with other research institutions and agencies. These include the Forage Unit, Lacombe Research Centre at Lacombe (forages), the Agriculture and Agri-Food Canada Research Station (AAFC) at Lacombe (forage corn) and the Alberta Research Council at Vegreville.

The following companies sponsored adaptability trials in 1999: Advanta Seeds Pacific (Oregon, USA); Cascade International Seeds (Oregon, USA); Cebeco International Seeds (Oregon, USA); Cebeco Zaden (Netherlands); Dawson Seed Co. (B.C.); Lesco (Oregon, USA); Montana Turfgrass Technologies (Montana, USA); Newfield Seeds (Sask.); Northstar Seeds (Man.); Oseco/ABT (Ont.); Parsons Seeds (Ont.); Peace Valley Seeds (Alta.), Pickseed (Ont.); Proven Seeds (Alta.); Scotts Co. (Oregon, USA), and Turf Seed (Oregon, USA).

The program leader, H. Najda, also provides information services to other AAFRD staff and producer and commodity organizations. Details of research trials are presented in *Grass Seed and Forage Crops Program Annual Report 1999*, CDCS Pamphlet 2000-9.

Research Projects

Perennial Forage Crop Studies

Perennial grass seed production under irrigation

This has become a major area of research in southern Alberta. Many seed companies from the United States and Europe are now contracting production acres in southern Alberta both under irrigation and dryland. Agronomy trials on tall fescue and perennial ryegrass were conducted at Brooks and Bow Island. These included companion cropping studies, fertility trials and dates of seeding trials.

In 1998 the Western Grass Seed Testing Program (WGST) was initiated to provide seed yield and adaptability information to the seed industry. The trials are coordinated by the grass seed and forage crops program at CDCS and is a cooperative effort of the federal and provincial governments and the seed industry. Testing sites are located at Fort St. John, British Columbia; Beaverlodge, Bow Island and Brooks, Alberta; Melfort and Outlook, Saskatchewan; and Arborg and Portage La Prairie, Manitoba. The grass seed and forage crops program at CDCS is responsible for seed acquisition and distribution to test cooperators and production of an annual report for seed producers and the seed trade. Species currently being tested are meadow, slender, hard, tall, sheep and red fescues, Kentucky bluegrass, perennial ryegrass, smooth bromegrass, orchard grass and bentgrass.

Perennial forage variety testing

This was the ninth production year of this province-wide program evaluating perennial forage species and varieties. This program is funded by Alberta Agriculture, Food and Rural Development (AAFRD) and coordinated by the Forage Unit, Lacombe Research Centre. Species tested include alfalfa, bromegrass, the wheatgrasses, timothy and orchard grass. The grass seed and forage crops program, at CDCS, is responsible for conducting irrigated and dryland trials at Bow Island and Brooks and for compiling and analysing data from all the provincial sites and preparing the annual report for the Alberta Forage Variety Committee (AFVC) of the Alberta Forage Council. This testing program provides information that allows producers to base crop decisions from a wide range of forage varieties tested. Data have indicated that there are significant differences in variety performance in the different agroclimatic areas of the province. Results of the trials are now available to the producer in the updated Agrifax pamphlet *Varieties of Perennial Hay and Pasture Crops for Alberta*. Agdex 120/32. This information is also available on the Internet at the AAFRD site: http://www.agric.gov.ab.ca

The Western Forage Testing Program (WFT) was initiated in 1995. This is a tri-province (Alberta, Saskatchewan and Manitoba) cooperative venture which tests forage varieties for registration purposes. Information generated from this testing program provides a basis for registration and in most cases, enough location years to provide data for particular agro-climatic areas. This efficiency will eliminate a minimum of four years testing over previous testing programs. In 1999, five alfalfa varieties and two timothy varieties were supported for registration by the AFVC.

Technology Transfer Services

The program leader, H. Najda, provides extension service to growers and industry personnel. In 1999, presentations were made at several industry and producer meetings and provincial advisory committees. Two information pamphlets on forage variety performance were updated. The program leader participated on the Forage Product Team, the Alberta Forage Variety Committee, the Forage Association Grant Committee, the Alberta Alfalfa Seed Committee, the Western Grass Seed Testing Committee, the Western Forage Testing Committee, and the board of the Chinook Applied Research Association. The program leader also participated in seed judging for the North American Seed Fair held at Ag-Expo, Lethbridge.

Horticulture Unit

Entomology and Micropropagation Program

K. Pruski, J. Motta, T. Lewis, N. Geschke and K. Fry (Alberta Research Council)

The entomology program at Crop Diversification Centre North (CDCN), Edmonton continued providing Alberta growers with extension and research in insect control and integrated pest management (IPM). The program conducts applied research to provide up-to-date information on the utilization of non-chemical methods to control insect pests in horticultural crops and conducts surveys to determine insect population dynamics. The focus is placed on preparation and delivery of extension services to Alberta growers and to increase their knowledge and skills in recognizing pests and applying correct pest management methods.

The program established extensive cooperation with entomologists within the province and across Canada. These include the Agriculture and Agri-Food Canada Research Station (AAFC) in Lethbridge, AB, Atlantic Food and Horticulture Research Centre, AAFC, Kentville, Nova Scotia (NS) and Alberta Research Council (ARC), Vegreville, AB.

The program leader, K. Pruski, also provides information services to other AAFRD staff and to producer and commodity organizations.

The micropropagation program is focused on germplasm storage/maintenance, tissue culture research and extension. The program is also providing private tissue culture laboratories in Alberta with the mother stock cultures for micropropagation.

Tissue culture plant material available at CDCN during 1999 included:

Species	Cultivar
Chokecherry	Garrington, Goertz, Robert, Lee Red, Yellow Boughen
Mongolian cherry	#2, #4, Beaverlodge selections
Nanking cherry	Black, White (Lee Orchard)
pincherry	Liss, Jumping Pound, Lee selections: #1, #2, #3, #4
raspberry	Wyoming (black), Redbrook
saskatoon	Bluff, Buffalo, Forestburg, Honeywood, Lee#3, 5, 8, 10, 11, 12, Martin, Moonlake, Nelson, Northline, Pasture, Parkhill, Pembina, Quaker, Regent, Smoky, Success, Thiessen
sour cherry	Evans cherry, Lutowka (Schattenmorelle)

Education Leave

The entomology technologist J. Motta enrolled in a M.Sc. program at the University of Alberta and completed a four-month education leave from September to December. This leave should allow the technologist to develop new skills which can be applied to the program. This graduate program is anticipated to take another three years before completion.

Special Leave

The entomologist, K. Pruski, spent the last three months of 1999 at the Nova Scotia Agricultural College and at the Kentville Research Station, NS working on collaborative integrated pest management (IPM) projects in small fruit crops for Alberta and on publications. This leave allowed the entomologist to develop a joint collaborative IPM project and to complete and submit two manuscripts for publication.

In the entomologist's absence, Dr. Ken Fry from Alberta Research Council has been handling K. Pruski's extension duties.

Research Projects

Integrated pest management approach in control of root maggots in cabbage crops in Alberta

The second year of the project was completed. The project is conducted in cooperation with the vegetable program at CDCN. Research is focused on the effectiveness of several non-chemical products in the control of cabbage root maggots. Determination of root maggot life cycle in central Alberta is also one of the main objectives of this study. The trials are conducted at the CDCN location. The project is funded by: Alberta Market Gardeners Association; Alberta Horticultural Congress; Garlic Barrier Organic Farms (P. E. I); Koppert Canada; Mycotech (Butte, MN, USA) and Alberta Agriculture Research Institute (AARI).

In the 1999 season the entomopathogenic fungus, *Beauvaria bassiana* was also included in treatments. After two growing seasons, data collected indicates good insect repellent properties of the Garlic Barrier^{R} when used as a soil drench. Work on this project will continue in 2000/01, industry funds are in place for the 2000 growing season.

Evaluation of Orthene^{R} and entomopathogenic nematodes against woolly elm aphids and its effect on fruit yield in saskatoons

This is a joint project between CDCN and ARC, Vegreville. Dr. Ken Fry is the project leader. It is conducted at the CDCN location. A one-acre saskatoon test field was planted in 1997 and is used for the study. This is a long term project (7 years) partially funded by the Alberta Profesional Horticultural Congress Foundation, ARC and AARI. The insecticide Orthene^{R} and nematodes *Heterorhabditis megidis* are being tested against woolly elm aphid (WEA). The WEA is a common insect of saskatoons which can devastate young saskatoon plantations if left uncontrolled. Both, the chemical and the nematodes can be included in the IPM system for saskatoon orchards.

Insect survey in mature saskatoon orchards

The insect survey was conducted at three different sites. Two commercial saskatoon orchards in Edmonton area were chosen and the CDCN location. At the CDCN location this was the third consecutive year of insect monitoring. Yellow sticky traps and pan traps were used to monitor and collect insects. The objective of the study is to map the insects inhabiting saskatoon orchards around Edmonton. This is a collaborative work with Dr. Ken Fry, ARC, Vegreville.

Insect survey in bedding plant greenhouses (Edmonton area)

Several bedding plant greenhouses around Edmonton were chosen for the survey. Fungus gnats again were the primarily occurring insects at all surveyed locations. Results were comparable with the 1998 growing season.

Potato microtubers in seed potato production in Alberta

The 1999 season was the last year of this project, data has been collected and the final report is under preparation. The project was funded by the Potato growers of Alberta and with matching funds from AARI. Research work was conducted at CDCN location, in the tissue culture laboratory, seed potato greenhouses and at the field. The project was a collaboration with the CDCN seed potato program.

Technology Transfer Services

The program leader, K. Pruski, provides extension services to growers and industry personnel. In 1999, seminars and presentations were made at several industry and producer meetings. Many aspects of insect pest management were discussed with individual growers. IPM was a focus of most of discussions and meetings. An insect identification workshop for fruit growers was organized in cooperation with Dr. Ken Fry, ARC. Extension work was carried out through commodity newsletters, *Greenhouse Coverings* (16 articles), *Prairie Fruit Grower* (2 articles), *Fruit Facts* (4 articles), phone calls, on-site visits, seminars, lectures and workshops. The program leader participated in several meetings on IPM cooperation between Kentville Research Station, Nova Scotia Agricultural College and CDCN. These actions resulted in development of a plan for a long-term research collaboration between the parties. Research will focus on IPM in small fruit crops in Alberta. The jointly developed project on IPM in strawberries and saskatoons already has received financial support from the industry.

The program leader provides extension to private tissue culture laboratories and growers interested in establishing new laboratories. A tissue culture course was organized in January '99. Consultations and problem solving were carried out via phone calls, fax and office visits.

Fruit Crops Program

L.G. Hausher and S. Dalpé

The provincial fruit crops program conducts adaptation and agronomic research in support of the developing and expanding berry and bush fruit industry in Alberta. Information generated from trials forms the basis of fruit crop recommendations provided to producers directly through producer organizations, and extended through Alberta Agriculture, Food and Rural Development staff.

Strawberries, raspberries, saskatoons and black currants are the major crops studied, although additional fruit crops are also evaluated for their commercial production potential.

The majority of trials are conducted at Crop Diversification Centre South (CDCS) with additional trials conducted at Crop Diversification Centre North (CDCN).

Details of all research trials are reported in CDC South Pamphlet *Fruit Crop Trials 2000-6*.

Research Projects

Strawberries

Four Junebearing strawberry adaptation trials were conducted to obtain production, quality and adaptability information of strawberry cultivars and selections. Advanced strawberry selections from Agriculture Canada breeding programs at Kentville, Nova Scotia, and St. Jean-sur-Richelieu were evaluated with information provided to breeders to assist in varietal release decision discussions.

A total of 25 cultivars and 11 selections were evaluated.

Three Nova Scotia and one Quebec selection have recently been named and released.

Junebearing strawberry agronomic studies included evaluating the first year production potential of newly planted strawberries. Present management practices suggest not fruiting Junebearing strawberries during planting year. The timing of removal of winter straw mulch protection of Junebearing strawberries was also examined with respect to its affect on winter survival, yield and earliness of production.

A day-neutral strawberry cultivar evaluation was conducted to obtain production, quality, and adaptability information of three new day-neutral cultivars as compared to industry standards.

Raspberries

Six new cultivars of floricane raspberries were grown and harvested to evaluate adaptability, production and quality information as compared to three industry standard cultivars.

One new primocane cultivar was studied to access its acceptability and production potential in comparison to industry standards.

Eight primocane raspberry cultivars were studied for earliness and production potential with the application of fiber row covers.

Saskatoons

A well established saskatoon orchard consisting of ten cultivars of saskatoons were rejuvenated by mowing to near soil surface during early spring months of 1999.

Regrowth and plant health were measured. Many original commercial saskatoon orchards are in need of rejuvenation but the industry requires information on techniques, orchard management, and post-rejuvenation yield response.

Black Currants

A black currant adaptation trial was conducted to obtain production, fruiting patterns, quality and adaptability information on 14 cultivars. Plant material was obtained from Ottawa, Pennsylvania and British Columbia. Additional cultivars were established in 1999 with plant material obtained from Scotland.

Agronomic study with black currants consisted of evaluating pruning methods on four black currant cultivars.

Financial assistance from the Alberta Market Gardeners Association is appreciated and acknowledged in support of these black currant studies.

Gooseberries

Fifteen cultivars of gooseberries were evaluated to obtain production, quality and adaptability information.

Cherries

Mongolian cherry and chokecherry orchards were regenerated by mowing near ground level to evaluate regrowth and disease patterns. Evans sour cherry was fruited to establish yield potential.

Technology Transfer Services

The program leader, L. Hausher, provides extension services to producers, producer organizations and Alberta Agriculture, Food and Rural Development staff.

Fruit Facts, a newsletter providing berry producers with up-to-date production and marketing information, was published monthly. Articles were prepared regularly for the Alberta Market Gardeners Association (AMGA) and the Fruit Growers Society of Alberta newsletters. A commercial berry production school was conducted in Red Deer.

The program leader continued as secretary of the Alberta Professional Horticultural Growers Congress and Foundation Society; the Alberta Horticultural Congress Foundation; The Horticultural Congress Planning Committee; The Alberta Society for Professional Horticultural Advancement; and the Alberta Market Gardeners Association (AMGA).

Presentations were made to research, commodity, and advisory groups during the year. Assistance was provided in the planning and execution of the Alberta Horticultural Congress.

A Black Currant Research Openhouse was held at CDCS in July, 1999.

Financial assistance from the AMGA made it possible to attend the North American Strawberry Growers Association, and North American Bramble Growers Annual Meetings.

Greenhouse Crops Program (Brooks)

J. Calpas, P. Coté, S. Graham, M. Konschuh and C. Toews

The greenhouse crops program at the Crop Diversification Centre South (CDCS) serves southern Alberta's diverse greenhouse vegetable and floriculture industry through comprehensive extension and research programs. The greenhouse crops program at CDCS works in cooperation with the greenhouse crops program at CDCN in Edmonton. The two greenhouse crops programs are the sole sources of provincial research and extension expertise for the Alberta greenhouse industry.

Research into new crop development, new technology and improved crop production techniques, is the main focus of the applied research program. The basic research program is directed towards reducing the negative environmental impact of greenhouse crop production. Basic research is currently being conducted on the development of biological controls for *Botrytis cinerea, Pythium* spp. *Rhizoctonia solani* and *Fusarium* spp. in greenhouse crops.

Research undertaken by the greenhouse crops program has a strong market-driven focus, working with industry greenhouse product marketers. Research is directed at improving the access of Alberta product into proven and developing markets across Canada and the U.S.

The program has identified market opportunities and has worked to remove the barriers facing the industry's access to these opportunities i.e. cluster tomato market, increased market demand for greenhouse lettuce and beefsteak tomatoes, increasing market demand for reduced pesticide use in greenhouse vegetable crop production, just to name a few.

The research greenhouse crops are grown to approximate commercial greenhouse crops and attain commercial levels of production. Greenhouse research projects target the distinct Alberta greenhouse growing environment and provides information on the optimal use of inputs and crop handling techniques specifically for Alberta conditions.

A number of trials are conducted in close association with grower organizations and industry partners. These include: Red Hat Cooperative; Air Liquide Canada; Spray Lakes Sawmills; Olds College; University of Alberta; Westgro Horticultural Supples Ltd. and Applied Bionomics. Trials are also conducted in cooperation with other department and provincial government agencies, as well as other educational and research institutions, including Pest Management and Prevention Unit (AAFRD), Department of Environmental Protection, Olds College and the University of Alberta.

Research trial reports are presented in *Greenhouse Coverings*, the greenhouse crops program monthly newsletter which is also available on the Internet.

The program leader, J. Calpas, provides information and expertise to other AAFRD staff, allied industry, financial institutions, community planners and to grower organizations.

Research Projects

Efficacy of precision placement carbon dioxide supplementation in greenhouse sweet pepper production

The efficient use of carbon dioxide supplementation in Alberta greenhouse vegetable crop production represents a significant opportunity to increase yield. This project was initiated in 1998 after Alberta greenhouse vegetable growers identified improving carbon dioxide supplementation efficiency as an industry priority.

The project is a cooperative effort between the greenhouse crops program, the Red Hat Cooperative, Air Liquide Canada and receives matching funding from the Alberta Agricultural Research Institute. This was the second year of funding for this project which will be concluded in 2000.

The focus of the project is to design a carbon dioxide supplementation system to improve the distribution of carbon dioxide within the plant canopy and define the

parameters that allow for cost-effective carbon dioxide supplementation under southern Alberta greenhouse growing conditions.

Development of crop diversification opportunities for Alberta greenhouse growers

Crop diversification is a core responsibility of the greenhouse crops program at CDCS. Research in 1999 completed work on establishing cluster tomatoes as a crop diversification opportunity for Alberta greenhouse tomato growers. There are now approximately 6 acres of commercial greenhouse cluster tomato production in Alberta.

A shallow floating-bed hydroponic lettuce production system was developed in order to offer an opportunity for vegetable growers to keep their plant nurseries in production after the vegetable transplants have been moved into the main production greenhouse. The nurseries are often dedicated areas equipped with benches and are not conducive to tall vegetable crop production. The shallow floating bed system allows for the rapid/inexpensive conversion of the nursery into lettuce production. Butterhead, romaine, and leaf lettuce all performed well in the shallow floating bed system as did baby bok choi, Swiss chard, and spinach.

Scotch bonnet peppers (*Capsicum chinense*) represents some of the hottest peppers in the world, and are popular on the fresh market as well as a processed product in hot sauces. There are Alberta processors who are using scotch bonnet peppers imported from Trinidad to make their sauces and who were looking for a local source of the pepper. Work at CDCS has demonstrated that high quality scotch bonnet peppers, suitable for fresh market and processing, can be grown in Alberta greenhouses. Work is ongoing to determine the cost of production and the most efficient crop production schedules.

Culinary basil was grown for the third year and continued to be well received by the wholesale trade, specifically for restaurants. Work focused on the large leafed Genovese types which proved to be consistent, high yielding types. There is opportunity for Alberta growers to make in-roads in supplying basil to the food service industry, a market traditionally held by growers in British Columbia. The biggest production issue to be addressed is the rapid wilting of the fresh cut product, even with immediate refrigeration. The quality of the product remains very high in spite of the wilted appearance.

Limonium (perennial statice) continued to be grown as a cut fill flower replacement for baby's breath in flower arrangements. The quality of the product grown in Alberta surpasses the quality of the imported product from California and New Zealand, and is very well received by the floral trade. New cut flower varieties investigated in 1999 included Physostegia and Lysimachia, work is continuing on determining the cost and return analysis of these crops.

Development of biological controls for greenhouse crop diseases

The greenhouse crops program has a long-standing commitment to biological controls, the research vegetable crops have be grown without the use of pesticides for five years. This commitment reflects the overall commitment of the Alberta greenhouse industry towards the use of biological control agents for greenhouse pests.

In addition, developmental work on biological control agents for common greenhouse diseases has been ongoing over the past year. Work has primarily targeted the gray mold pathogen, *Botrytis cinerea*, using Alberta isolates of *Trichoderma* spp., a fungal genus known for its activity against disease causing fungi. New projects were initiated to develop biological controls against common root pathogens, *Pythium* spp., *Fusarium* spp. and *Rhizoctonia solani*.

Industry cooperators were Spray Lakes Sawmills, the University of Alberta, and the Prairie Turfgrass Research Centre at Olds College. The bulk of funding for the *Botrytis* project was provided by an Alberta Agriculture Research Institute direct funding grant.

Application of genetic fingerprinting technology

Through the biological control program, the greenhouse crops program has developed considerable expertise in the genetic fingerprinting of fungi and other organisms. Two independent projects were undertaken in cooperation with Pest Management and Prevention Unit, and the Department of Environmental Protection, to develop genetic fingerprints for the European elm bark beetle and the mountain pine beetle. The objectives of the projects were to develop rapid, DNA based identification procedures for these beetles which could be used on partial specimens, and to determine whether individual beetles could be identified with respect to "regional" parent populations of beetles.

Technology Transfer Services

The program leader, J. Calpas, provides extension service to growers, AAFRD and industry personnel. Telephone and on-site consultations with greenhouse growers regarding crop management concerns and problems comprise a large part of the extension activities. Transferring crop production expertise regarding new crops and improved production techniques and technology is also a strong component of the extension service.

Several presentations were delivered at industry and producer meetings.

The program leader also provides information to other department staff; rural development specialists, marketing specialists and Horticultural Product Team. Consultations with loans officers of private banks and the Agriculture Financial Services Corporation are also routine.

The innovation and determination of the greenhouse crops program team at CDCS was recognized by AAFRD. This group was one of six Group Achievement Award winners for 1999.

The program also has a grower training program which provides hands-on crop management and production training to individuals interested in becoming commercial growers. This program has produced growers who have gone on to become established owner/ operators of successful commercial greenhouse businesses.

Greenhouse Crops Program (Edmonton)

M. Mirza, M. Younus and, W. Chen

Greenhouse vegetable production area in central and northern Alberta continued to expand in 1999. A state-of-the-art, 8000 m^2, facility in the Lacombe area has produced its first crop of peppers. Another 8000 m^2 facility is currently under construction. This facility will incorporate the new technologies, biofilters, carbon dioxide recovery from boiler stacks and a central inflation system. Sawdust continued to be the main growing medium with a growing interest in coir (coco nut fiber). Lettuce production area increases slightly, with a major greenhouse facility expected in the Edmonton area. The area devoted to bedding plants and potted ornamentals continued to expand in rural areas. Tree seedling production area increased by 15%, in year 2000, close to 100 million seedlings are expected to be available for reforestation. Cut flowers area remained stable with many growers switching over to coir as a growing medium and using slow drip irrigation systems. One grower is experimenting with new varieties of Gerbera as a cut flower.

Evaluation of coco peat (coir) compared to sawdust for tomato production in the second year

Sawdust and coir in pillow bags, which had produced a crop of tomatoes 1998 was evaluated again in 1999 for tomato production. The 1998 crop was removed the third week of November and the bags were allowed to partially dry out. Blitz tomato was seeded the first week of January and transplanted on to both media the second week of February at a density of 2.5 plants/m^2. The first harvest began the end of March and the crop was removed the end of September. There were no significant ($P \leq 0.05$) differences in the total weight or number of fruit per square meter between the two growing media, but an over all reduction in fruit size was apparent in both. The plastic used for the bags started deteriorating and needed careful handling. Coir is comparable to sawdust for two year production cycles, longer use is possible if nursery containers are used.

Evaluation of two irrigation systems for the production of seedless cucumbers

A pulsator-controlled minute drip irrigation system was compared with a conventional fast drip irrigation system for cucumber production during 1999. The pulsator system delivers smaller amounts of water per unit of time compared to the conventional irrigation system. The pulsator system allows for the horizontal spread of water and nutrient solution, less water is leached out. Cucumber cv. Harmonie was seeded the first week of January and transplanted into 26 L sawdust bags the first week of February. The irrigation systems were set up. Harvest began the first week of March with the crop terminated the third week of May. Data were taken on % leachate/8 plants and marketable fruit yield (kg/sq m). There was no significant ($P \leq 0.05$) difference in total weight or number of fruit between the two systems. The average amount of leachate in the conventional drip system was 33% as compared to 10.5% in the pulsating drip system. The pH and E.C. values in the leachate were comparable in both systems. The delivery of irrigation water through a pulsating system is an effective means to avoid excessive over drain and thus reduce the amount of waste water.

Effect of different levels of phosphorus on the growth of *Echinacea angustifolia* plugs

E. angustifolia seeds were surface sterilized with 0.5% bleach, soaked in water for 24 hours and soaked again in a 400 ppm of ethrel and water solution for two hours then seeded into perlite. The plants were germinated at 22 °C under constant light at 7000 lux. Once germinated, the seedlings were transplanted the first week of May into 128 cavity bedding plant plug trays filled with a commercial soilless mix. The second week of May, the seedlings were fertilized with three levels of phosphorus; 5, 20 and 38 mg/L as a part of a regular fertilizer program. The fertilizer solution also contained the macro and micro elements essential for growth. Fertilizer treatments continued until the second week of July. Plugs were pulled from the trays, rinsed clean in water and the fresh and dry weights of shoots and roots were recorded. There were no significant differences in root and shoot dry weight ($p \leq 0.05$) and fresh weight. The echinacosides in the roots (as determined by HPLC method) were: 1.37% at 5 mg/L of phosphorus, 1.20% at 20 mg/L of phosphorus and 1.25% at 38 mg/L of phosphorus. *E. angustifolia* plugs can be grown by providing phosphorus at 5 mg/L as a constant feed.

Effect of different levels of nitrogen on the growth of *Echinacea angustifolia* plugs

The germination and plug management practices were the same as in the phosphorus study. Thirty-one day old seedlings received 100, 150 or 200 mg/L of nitrate nitrogen as a part of a complete nutrient solution with phosphorus supplied at 5 mg/L. The treatments were continued until the seedlings were 54 days old. Plugs were removed from the cavities, washed clean and the fresh and dry weights were determined. No significant difference was found in either the fresh or dry weights of the roots when compared at 5% level of significance ($P \leq 0.05$) in all three nitrogen treatments. On the fresh weight basis, the shoots from plants grown on 100 mg/L of nitrogen showed a

significant difference from those grown on 250 or 200 mg/L of nitrogen. However, the difference was not significant on dry weight basis. For *E. angustifolia* plugs 100 mg/L of nitrogen is adequate.

Effect of planting density on the root and shoot growth of *Echinacea angustifolia*

Echinacea angustifolia was seeded the second week of February and germinated according to the protocols above. Nine week old plugs were transplanted into one square meter wooden bins containing a commercial soilless mix. The plugs were planted at a density of 48, 97 and 172 plants/sq m. The plants were fertilized with a complete nutrient solution on a regular basis. Biological controls were used for thrips infestations. The plants were harvested the third week of October. Roots were washed and fresh and dry weights were taken of roots and shoots. Significantly higher fresh root weights were obtained at a density of 172 and 97 plants/sq m when compared with a density of 48 plants/sq m although the dry root weights were not different. At lower densities plants produced significantly higher fresh shoot biomass.

Production of *Echinacea angustifolia* in different size of containers

Spencer-Lemaire plastic trays with 200, 500 and 1000 ml volumes were used to grow a crop of *Echinacea angustifolia* in the greenhouse. Twelve week old plugs of *E. angustifolia* were planted into these different volume containers the third week of June. The roots were harvested the third week of November. The root dry weight was significantly lower in plants harvested from 200 ml capacity containers when compared to plants grown in 500 and 1000 ml containers.

Production of *Echinacea angustifolia* using an organic fertilizer

Ten week old seedlings of *E. angustifolia* were planted the third week of June into 4 liter plastic pots containing a commercial soilless mix which was amended with 5, 10 or 20 grams per liter of a certified organic fertilizer. The organic fertilizer was manufactured from vegetable and labeled 6-2-4. The control plants were fertilized with regular greenhouse grade fertilizers while the plants in the other treatments received only water throughout the duration of the crop. The pH and electrical conductivity was monitored weekly. The plants were harvested at the end of November with the fresh and dry weights of roots and shoots being determined. The root dry weight was significantly higher in all plants which were grown in medium amended with the organic fertilizer when compared with plants grown in a medium with regular fertilizers. Further research will be conducted with organic production of Echinacea.

Ethanol, natural ethylene and germination of *Echinacea angustifolia*

Adele Mandryk, The King's University College and M. Mirza

This study was carried out as an Independent Studies Project Biology 496X and made several conclusions. Seed surface disinfection was achieved by using 100% ethanol for 5 to 20 minutes and was as effective as using 0.5% bleach for five minutes. Herbal tinctures of calendula, Echinacea, horsetail and garlic were ineffective in suppressing fungal infection from the seed surface. The germination of *E. angustifolia* can be enhanced by exposing the seeds to avocado and apples but not bananas. There was no significant difference in the percentage germination of *E.angustifolia* when exposed to 400 ppm of ethrel or the fruit. This study will help to develop organic germination protocols for commercial growers.

Echinacoside distribution studies in *Echinacea angustifolia* roots produced in field

Yumiko Hoyano, Bob Currie, Food Safety Division, AAFRD and M. Mirza

Nine root samples were collected from two year old *E. angustifolia* grown at CDCN on May 25, July 26 and September 30, 1999. Each root sample was washed to remove dirt, freeze dried and ground to provide homogenous powdery sample. The analysis of echincosides was carried out in duplicate using methanol extraction and HPLC methods. The roots obtained from plants in May, July and September had an average echinacoside

content of 1.64% ± 0.432%, 2.06% ± 0.323, and 1.15% ± 0.220 respectively. The hypothesis that echinacoside content will increase towards fall harvest time was not supported by this data. When single roots were analyzed by cutting into smaller pieces, the echninacoside content ranged between 1.06 and 2.198%.

Observations on the production of Gotukola in greenhouses

Gotukola (*Hydrocotyle asiatica or Centella asiatica)* is a small creeping plant used for centuries in India and Siri Lanka for its rejuvenating properties. The purpose of this study was to examine the possibility of growing it as a greenhouse crop. Four crops were grown from April to December in a commercial soilless medium. The plants were fertilized with complete greenhouse grade fertilizers on a constant basis. The average fresh weight was 8724 grams/sq m while the average dry weight was 850 grams/sq m. The plant is susceptible to spider mites and biological controls were effective. The samples are being analyzed for quality. Further studies are being conducted to increase the biomass and effect of nitrogen on biomass development.

Production of fresh Fenugreek as a vegetable green

Fenugreek has a potential of growth as a leafy green vegetable for greenhouse production. Research is focused on developing information on year round production and identify insect and disease problems. The plant reaches a harvest stage between 30 and 40 days from seeding. A row spacing of 30 cm produced 1.087 kg of fresh leaves and stems/sq m. Twenty grams of seeds seems to be adequate for each sq m of space. In one study six unnamed cultivars obtained from CDCS, Brooks were evaluated for leaf and stem yield potential. One cultivar yielded 1770 grams/sq m of marketable leaves and stems. The quality was rated high by a local store which imports fenugreek from the United States. Further research is being conducted with increasing the biomass and thrip control.

Evaluation of coir (coco-peat) as a growing medium for white spruce seedlings

Seeds of white spruce were seeded the third week of January in 112 styroblocks containing either a commercial soilless mix or coir or 75% coir and 25% styrolite. Styrolite is an inert material which makes the growing medium more porous. One block contained 112 plants with five blocks in each treatment. Each block was considered a replicate. Standard greenhouse cultural practices were followed. The third week of September the height and caliper was recorded and data were analyzed. The height and caliper differences between plants grown in 100% coir and a commercial soilless medium were non significant ($P \leq 0.05$). The height and caliper of plants grown in 100% coir was significantly higher when compared to plants grown in a mixture of coir and Styrolite.

Graphical tracking of poinsettia in Edmonton area

Graphical tracks for seven poinsettia cultivars (Freedom Red, Cortez, Marbel Star, Maren, Sonora, Snora Red and Orion Red) were prepared starting in the third week of August. The crop was tracked for 11 consecutive weeks with the last tracking done November 4. The growth pattern as measured by height and number of leaves were consistent between the seven cultivars. All cultivars finished between 14 to 18 cm height with 33 to 42 leaves and 5 to 7 bracts. The graphical tacks of these seven cultivars will be provided to the poinsettia growers for monitoring their crops in future.

Preliminary results of bicontrol of Pythium damping-off in cucumber with *Paenibacillus polymyxa* PKB1

Yang, J., P. Kharbanda, Alberta Research Council, Vegreville and M. Mirza

Pythium isolates were collected from various greenhouses in Alberta and tested for their pathogenicity on cucumber seedlings. Bacterium *Paenibacillus polymyxa* PKB1 was tested for its inhibitory effect against different *Pythium* isolates in vitro. Effect of seed treatment with PKB1 to control pre-emergence damping-off on cucumber was

tested in petri plates and in a growth chamber. All *Pythium* isolates collected caused pre-emergence damping-off of cucumber but the pathogenicity varied among the isolates. PKB1 significantly inhibited the mycelial growth of *Pythium* isolates on potato dextrose agar and nutrient agar. PKB1 coated cucumber seeds had significantly higher germination and survival than un-coated seeds when tested in water agar culture plates. Similar results were obtained from growth chamber test when PKB1 coated seeds were planted in greenhouse soil mix and inoculated with *Pythium*/cornmeal/sand inoculum. The results indicate that PKB1 could be applied as a bicontrol agent to control *Pythium* disease and possibly some other soil-borne diseases in greenhouse crops. Research is being conducted in recirculating and closed sawdust bag systems.

Technology Transfer Services

Greenhouse planning and production information was provided to over 300 people during the year. *Greenhouse Coverings*, workshops and on site visits continued to be the major technology transfer tools. Use of email for information transfer increased considerably during the year with several growers sending images of their crops for diagnostic purposes. Several articles in *Agrinews* were picked up by media which generated in information transfer.

Horticulture Development

B. Vladicka, S. Demers Collins

The objectives of this program are to:

- facilitate the development of markets for Alberta horticultural products as a commodity and as value-added products,
- provide assistance to the industry to improve its competitive position,
- administer the Farmers' Market program across the province.

Activities that helped the Horticulture Unit achieve AAFRD's goals during the year are highlighted below.

1999 marked the 25th anniversary of the Farmers' Market Program. Many markets held special events to mark the occasion. Our office assisted the Alberta Farmers' Market Association (AFMA) with the production of an anniversary cookbook and table top displays, and other promotional events. By year end, there were 116 approved farmers' markets in the province. Each year, a directory of all the approved markets is produced and distributed across the province.

The Farmers' Market Administrator is an ex-officio member of the board of directors of AFMA. Assistance was provided to the association in planning their annual meeting and general financial management.

The Fruit Growers of Alberta promoted fresh fruit through two major initiatives. Berry festivals which were held in late July, at the U of A Devonian Botanic Garden and two farmers' markets. Public support was very positive and the participating growers were pleased. The Association also produced the Prairie Fruit Guide, a directory of members with farm gate sales of fruit.

To help producers in their efforts to diversify, information on opportunities in horticulture and organic agriculture was provided through one-on-one sessions and in various workshops, tours and presentations. The publication, *Commercial Tree Nursery Industry*, was added to the AgVenture series of business profiles. Another series of publications developed in 1999 was a series of profit planning tools. *Strawberry Profit$* and *Tree Nursery Profit$* enable managers to assess all the key production and financial variables for their enterprises. The diversification activities are the efforts of a team of specialists from across the department.

Another intra-departmental team that Vladicka is involved with, has initiated a number of activities supporting producers and processors who use direct marketing channels. She helped in the development of many new publications that give clients more information about this method of marketing. This team has also produced a newsletter, *Direct From Farm to Consumer*.

Assistance was provided to the organic industry. Vladicka was a member of the certification committees for OCIA Alberta #1 Chapter and the Sustainable Agriculture Association. Upon completing the training offered by Assiniboine College, Vladicka became a qualified organic farm inspector.

Food safety has become one top concern of consumers. To maintain confidence consumers have in Canadian produce, the Canadian Horticulture Council (CHC) has developed standards for on-farm food safety. Vladicka has participated in the national discussions CHC has initiated with other players in the supply chain.

Vladicka has also been an active member of the Horticulture Product Team. The product team is a multi-disciplinary group that fulfills an integrating mechanism in the department's planning function. It addresses issues and opportunities facing the horticulture and apiculture industries in Alberta.

Nursery Crops Program

C.L. Murray, N.G. Seymour and T.T. Pheh

The nursery crops program is focussed on research into cultural management practices for commercial nursery production of both field and container-grown plants and the evaluation of new plant cultivars. Technology transfer activities included seminar presentations, magazine articles and research reports which are directed to growers and other members of the nursery-landscape trades industry as well as potential growers. A close association with Landscape Alberta Nursery Trades Association (LANTA) allows for excellent communication with the commercial industry.

C.L. Murray, program leader and N.G. Seymour, nursery crops technologist are based out of the Crop Diversification Centre South (CDCS) in Brooks and T.T. Pheh, nursery crops technologist is based out of the Crop Diversification Centre North (CDCN) in Edmonton.

The program leader also provides information services to other AAFRD staff and to producer and commodity organizations. Details of research trials are presented in *Nursery Crops Program, 1998*, CDCS Pamphlet 99-8.

Research Projects

Woody Plant Evaluation Trials

Prairie regional trials — CDCS and CDCN

The Prairie Regional Trials (PRT) were established in 1958 to evaluate the hardiness of woody plants on the Canadian Prairies and continue today in cooperation with Agriculture and Agri-Food Canada, Agri-Food Diversification Research Centre, Morden, Manitoba. The plants in the PRT are evaluated for five years at eight prairie sites including CDCS and CDCN. The growth and quality data collected each year are sent to Morden where a report is produced approximately every three years.

Regional woody plant test program — CDCS AND CDCN

Since 1983, Alberta Agriculture staff and the LANTA Growers Group and Research Committee have cooperated to develop and maintain The Regional Woody Plant Test Program (RWPTP). New tree and shrub introductions, generally from North America, are evaluated for five years at seven different sites representing different climatic regions

in the province. Growth and quality data are collected each year. For more information about the RWPTP from 1983-1998 see *Regional Woody Plant Test Project, Summary Report 1998, CDCS Pamphlet #99-26* or on the internet at http://www.agric.gov.ab.ca/crops/trees/rwptp/index.html.

The University of British Columbia plant introduction program — CDCS

The University of British Columbia Botanic Garden Plant Introduction Program selects superior plant material from many sources to test for suitability for introduction into the nursery-landscape industry. In 1998, the UBC selection, *Lonicera* 'Son of Mandarin', was planted at CDCS.

The perennial trial garden at the Calgary Zoo

In response to the huge growth in interest and sales of herbaceous perennials, the Calgary Zoo and Botanic Garden, LANTA Retail Operators Commodity Group and Alberta Agriculture have cooperated to develop the perennial demonstration and evaluation garden. The garden is located at the Calgary Zoo in the Dorothy Harvie Gardens. The project objectives are: 1) to evaluate new species and cultivars of perennials for hardiness and landscape quality under Chinook conditions; 2) to compile and publish the results for the public, retailers, growers and landscape professionals; 3) to increase the knowledge about new perennials for the public, retailers, growers and landscape professionals; 4) to provide a unique work experience at a public garden for a horticulture student.

All-America selections — CDCS

All-America Selections is a non-profit organization dedicated to promoting the development and introduction of improved cultivars of flowers and vegetables. The CDCS location is one of the approximately 35 trial sites in North America. The results of the evaluations from all the sites are tabulated and the best selections are released 18 months later. In 1999, nine new selections were evaluated.

Bur oak provenance trial — CDCN

The Bur Oak Provenance Trial is a cooperative trial originally organized by the Great Plains Agricultural Council, Forestry Committee and is coordinated in Canada by the Prairie Farm Rehabilitation Administration (PFRA) Shelterbelt Centre, Indian Head, Saskatchewan. The objectives of the project are: 1) to determine the nature and extent of bur oak genetic variation; 2) to provide genetically improved bur oak seed for shelterbelt planting; 3) to provide germplasm that can be used for selection and trait improvement as well as advanced-generation breeding; and 4) to survey the distribution and impact on seed quality of *Curculio* spp. (acorn weevil). The project began in 1993 and is expected to run for approximately 20 years. There are 48 accessions in the trial from the following locations: Manitoba (19), Saskatchewan (4), Minnesota (4), Montana (3), North Dakota (16), South Dakota (2).

Vineland apple rootstock trial — CDCN

The Vineland Apple Rootstock Trial is a cooperative trial with the University of Guelph, Horticultural Experiment Station, Simcoe, Ontario. The trial will evaluate the cold hardiness of the "V" series of rootstocks. There are currently four selections for the control (Ottawa 3, M9, Beautiful Arcade, Columbia) and five new selections bred at the Simcoe Station. The trees were planted in 1997 and will be on trial for five years.

Production Management Research Projects

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates — CDCN and CDCS

Field-grown plant material is the largest segment of the nursery industry in Alberta. There is inadequate information about the management of fertility for maximum tree growth in the short Alberta growing season, while avoiding over fertilization which may result in winter kill or dieback of trees. Colorado blue spruce seedlings and Summit (Edmonton) and Patmore (Brooks) green ash were planted on an unirrigated site in Edmonton and an irrigated site near Brooks and grown at four soil nitrogen (N) levels: control (no added fertilizer), 50, 90 and 130 kg N/ha.

There were no significant differences in tree caliper increase over the season, in 1997, 1998 or 1999 for ash or spruce in both locations, except for ash in 1999 at Edmonton, where caliper change over the season was greater at treatments 50 and 130 kg N/ha than at 90 kg N/ha. Tissue N content was not different for ash or spruce in 1998 or 1999 as a result of the N treatments. This research will continue for a minimum of two more growing seasons.

Investigation of sawmill by-products as media components for container production in the nursery — CDCS

Various forestry industry by-products such as bark chips and sawdust have been used in nursery production as media components to develop a medium that is cost efficient to make, easily available and with good physical characteristics such as adequate porosity and water holding capacity. Three species, Coronation Triumph potentilla, Goldflame spiraea and Colorado spruce, were transplanted into #2 containers, containing one of 12 media treatments. Treatments were composed of 25%, 50%, 75%, 100% bark chips or bark fines plus peat (varying amounts)and sand (10%) or bark fines (25,50,75%) plus bark chips (65, 40, 15%) plus sand (10%). The control was composed of 25% sawdust, 65% peat and 10% sand.

In 1998, the potentilla and spruce were largest when grown with 50% chips + 40% peat; spiraea were largest in the control. In 1999, potentilla were largest when grown with 25% fines + 65% peat; spiraea were largest in 50% fines + 40% peat and the control; spruce were largest when grown with 50% chips + 40% peat. The physical properties of the different media changed over the two seasons and may have impacted growth in the second season.

Evaluation of the effect of media, IBA concentration and timing on rooting efficiency for softwood cuttings of six species of woody plants — CDCN

A number of species of shrubs are considered by growers to be difficult-to-root using softwood cuttings and this limits their availability in the marketplace and increases the cost of production of these species.

Cuttings of new green shoots were collected from mature Saskatoon, beaked hazelnut, seabuckthorn, Mongolian cherry, pin cherry and Royal Purple lilac. Seabuckthorn cuttings rooted well, between 70 and 93%. The other species all had poor rooting in all rooting hormone treatments and at all three dates. The hazelnut had the greatest amount of rooting at 34% but all other species had less than 8% rooting.

Evaluation of POLYON and Japanese controlled-release fertilizers for growing woody plants in containers — CDCS

Controlled-release fertilizers are commonly used in nursery production for efficiency. Many of these fertilizer products have been developed in other nursery growing regions around North America and the world. To be effective these fertilizers need to be evaluated under Alberta climatic conditions. Alpine currants were grown in #2 containers at each of two N rates 5 or 8 g N/pot and with four different products: POLYON incorporated (21-9-12), and POLYON topdress (22-9-10), Urea 40-day (46-0-0), Urea 70-day (46-0-0), Urea 100-day (46-0-0) with a sigmoid curve release pattern.

The control was Osmocote controlled-release fertilizer 60% 3-4 + 40% 8-9 month release at 8 g N/pot. In 1998, the currants had larger dry weights when grown with the Urea 70-day fertilizer at the 8 g N/pot rate than with the Urea 40-day or Urea 100 day at either the 5 or 8 g N rate. The currants had the largest dry weights when grown with POLYON incorporated at the 8 g N/pot rate in 1999.

Altering the medium pH of container-grown woody plants utilizing various sulphur products and rates — CDCS

The medium used for container-growing woody plants is generally a soilless or low soil product with a low buffering capacity, so the pH of the medium is highly influenced by the quality of the irrigation water. Plant growth and quality are affected by high pH (above 7.5). Sulphur products can be used to reduce the pH of the container medium but little information exists on the rates required to reduce the pH or the affect on medium pH throughout the growing season.

Rooted cuttings of Goldflame spiraea and Scot's pine were grown in #2 containers with three sulphur products: elemental sulphur (0-0-0-95), Tiger 70 (6-0-0-70) and Tiger 90 (0-0-0-90) incorporated into the container medium at four rates 0.45, 0.90, 1.35 or 1.80 kg/m^3. Plants in the control treatment had no sulphur added to the medium. There were no significant differences in dry weight in the pine or the spiraea as a result of the different S types or rates applied. There was greater SO_4-S available in the medium where elemental S was used as a source than where either of the Tiger products were used.

Spring-forcing trial

Garden centres across Alberta sell many container-grown plants, many of which are imported into Alberta from other parts of Canada and the United States. Because the Alberta-grown plants are generally subjected to cool spring temperatures, they are not as far advanced in bud-break and leaf development as plants grown in milder climates and are not considered as attractive to the consumer as imported plants. In winter 1998-1999, the potential for spring-forcing of container-grown plants in Alberta was investigated with four species, Nanking cherry, Goldfinger potentilla, Daphne spiraea, and savin juniper and three forcing treatments: 1) plants were covered with a thermal blanket and bottom heat was delivered to the pots beginning heat 15 April 1999; 2) same as 1 but bottom heat was delivered beginning 26 April 1999; 3) control, no winter cover and no bottom heat.

The temperatures under the thermal blanket treatments were higher in winter than in the control. The heat was delivered to treatment 1 on 15 April, but the plants in treatment 2 that were supposed to receive heat April 26 were too far advanced by 22 April for extra heat to be effective. All plants in treatments 1 and 2, maintained under the thermal blanket, leafed out about three weeks ahead of the uncovered control plants.

Plant collections CDCS and CDCN

Plant collections have been developed and maintained at both CDC South and North as a living reference collection for use by horticultural professionals and the general public. The **Golden Prairie Arboretum** was established in 1981 at CDCS. The collection now contains 312 species of 68 genera for a total of 531 deciduous trees and shrubs. These plants represent most of the deciduous woody plant species that can be grown on the prairies. A complete listing of the collection is available in *Golden Prairie Arboretum, ASCHRC Pamphlet 93-1.* The **Forever Green Pinetum** collection of coniferous trees and shrubs at CDCS was established in 1986. At present it contains 26 species of nine genera for a total of 120 trees and shrubs. A complete listing of the collection is available in *Forever Green Pinetum, ASCHRC Pamphlet 93-12.* The **Rose Garden** contains 241 specimens, many of which are unique to the CDCS collection. Many early Canadian rose cultivars and notable crosses of Canadian rose breeders, Skinner, Bugnet and Wallace are maintained in the collection. At CDCN, the **McCalla Arboretum** has 192 taxa on display and is being redesigned as a lower maintenance landscape.

Technology Transfer Services

Technology transfer to the growers is accomplished through work with the LANTA Growers Group, Western Nursery Growers Group, nursery visits as well as by the production and distribution of the Nursery Crops Trial Report, magazine articles and the presentation of seminars. In 1999 the seminar 'Nursery Research Trials' was presented at the Alberta Horticultural Congress.

In August 1999, the program leader participated in the Western Nursery Growers Group, summer tour in the Niagara region of Ontario.

Plant PathologyProgram

P.S. Bains, H.S. Bennypaul, M. Yu and V. Kanrek

The plant pathology program at CDCN, Edmonton conducts research and provides technology transfer services to reduce losses caused by various diseases of horticulture and special crops. The program develops research projects and seeks research funds from various private and government agencies. During the past 10 years the program has received many research grants from these agencies.

Research Projects

Rhizoctonia canker and black scurf of potatoes (*Rhizoctonia solani*)

The project is funded by Potato Growers of Alberta and AARI and is in cooperation with Mr. C. Schaupmeyer, CDCS, Brooks.

Second year field trial conducted to evaluate the efficacy of fungicides in controlling rhizoctonia canker on potato stems and black scurf on progeny tubers provided the following results. Except lime, all chemical treatments including fludioxonil (Maxim) @ 0.33 or 0.5%, difenoconazole @ 0.33 and 0.5%, thiophanate-methyl, captan, iprodione, mancozeb, thiabendazole, difenoconazole (0.33%) +fludioxonil (0.33%), and difenoconazole (0.5%) +fludioxonil (0.5%) reduced incidence and severity of black scurf on progeny tubers. Only thiabendazole and both concentrations of fludioxonil, however were effective in completely inhibiting the development of black scurf on the progeny tubers. In 1997, fludioxonil @ 0.5% reduced both the incidence and severity but fludioxonil @ 0.33% reduced only the incidence of black scurf.

Based on these and previously obtained results, Novartis Crop Protection has applied for a registration of Maxim for potato seed treatment. It has passed the initial screening by the Pest Management Regulatory Agency. The company expects it to be registered by the end of 2000. Formulation of Maxim will be similar to and its price comparable to that of Easout. To manage the development of resistance against this single site action fungicide, efforts are already underway to combine Maxim with another fungicide, e.g. mancozeb or difenoconazole.

Potato cultivars tested showed a differential response to the pathogen, *Rhizoctonia solani*. Of 20 cultivars tested, Penia, Shepody, and Eramosa were comparatively most susceptible, whereas Rhodesta, Banana, and Amisk were comparatively least susceptible.

Fusarium dry rot of potatoes (*Fusarium* spp.)

The project is funded by Novartis Crop Protection and AARI. Drs. L.M. Kawchuk, Agriculture & Agri-Food Canada, Lethbridge, and J.D. Holley, CDCS are cooperators on this project.

Effect of fungicides as potato seed treatment in controlling the development of dry rot in progeny tubers was evaluated by determining the inoculum potential (potato Fusasria) of soil surrounding the progeny tubers by a potato disk baiting technique. Treatment of seed tubers with Maxim or imazalil (Fungazil) significantly reduced the inoculum potential of the soil.

Laboratory and field experiments were conducted to evaluate the efficacy of combinations of fungicides in inhibiting the *in vitro* growth *Fusarium sambucinum* and seed decay caused by the pathogen. Fludioxonil (Maxim) and combinations of fludioxonil with mancozeb (Tuberseal) or difenoconazole (Dividend) were most effective in inhibiting *in vitro* radial growth of a thiabendazole-resistant isolate of *F. sambucinum*. In a field trial, pre-plant treatment of *F. sambucinum*-inoculated seed with fludioxonil + mancozeb or fludioxonil + difenoconazole provided the most protection from seed piece rot. Protection provided by fludioxonil was similar to that of mancozeb. The effect of pre-plant fungicide treatment on spread of the pathogen from infected seed tubers was tested by evaluating the inoculum potential of the soil surrounding the progeny tubers. Fludioxonil at 0.5 % was most effective, followed by fludioxonil at 0.33 %, thiophanate-methyl and imazalil.

Saskatoon diseases

The project is funded by Fruit Growers Society of Alberta, Alberta Horticultural Congress and AARI, and is in cooperation with R.J. Howard, CDCS.

In 1999, surveys were conducted for incidence and severity of brown rot and mummy berry (*Monilinia amelanchieris*), cytospora die back and canker (*Cytospora leucostroma*), black leaf and witches' broom (*Apiosporina collinsii*), and rust (*Gymnosporangium* spp.) diseases of saskatoon. A minimum of three commercial saskatoon orchards in the Peace River (PR), north central (NC), and south central (SC) regions of Alberta were surveyed. The survey is a part of a project planned to identify fungicide(s) effective against the diseases.

Brown rot: The disease was found in every region. Incidence of the disease in SC region was lower than that in the NC and PR regions.

Cytospora dieback and canker: The disease was found in every orchard, and except in one orchard, 79-100% trees were infected. The disease on main stems was lower in the NC orchards than that on main stems in orchards in the other two regions.

Black leaf and witches' broom: The disease was not observed in two NC and one SC orchards, whereas two other NC and one SC orchards showed very high levels of the disease.

Saskatoon Rust: The disease was found both on leaves and berries. None of the NC orchards showed any disease. In all other orchards, incidence of the disease on leaves and berries ranged from 2.3-13.2% and 0.3-3.3%, respectively, and severity of the disease was 1.5-1.9 and 3.5-10.0%, respectively. Diseased samples were collected and number of cultures of the pathogens have been isolated. The cultures will be used for various laboratory studies.

Late blight of potatoes (*Phytophthora infestans*)

A large number of potato fields in the Taber, Lacombe and Edmonton areas were surveyed for late blight during the growing season. Except for an isolated incidence, where the disease pathogen was observed microscopically in a Canada Agriculture & Agri-Food laboratory, late blight of potato was not observed in Alberta. In this case the disease did not spread further. Other members of late blight patrol team included Dave Best, Nobby Fujimoto, Clive Schaupmeyer and Roy Shewchuk.

Early blight of potatoes (*Alternaria solani*)

Initiated a research project, "Early blight disease of potatoes (*Alternaria solani*): characterization of pathogen population and host-pathogen interaction.". The project is funded by Potato Growers of Alberta and AARI. The cooperators on the project include J.D. Holley and J. Calpas, CDCS.

A survey for early blight of potatoes was conducted in Edmonton, Lacombe and Taber area fields. The disease was found in every field surveyed. This disease has always been present in Alberta but in recent years it has been observed to cause significant economic losses in some fields. The irony is since early 1990's a majority of Alberta potato growers are applying protective fungicides for control of late blight

(Phytophthora infestans Mont. (de Barry)) which are also registered for control of early blight. More than 90% of the fields surveyed in this study received at least one fungicide application, with the majority of fields receiving more than one. The disease was found on all potato cultivars and was present at different levels of severity. The disease severity observations suggested that majority (61%) of the fields planted with Russet Burbank developed low levels of the disease. Differences in disease severity observed in different fields planted with the same cultivar may have been caused by variations in levels of inoculum, plant maturity, nutritional status, local environmental conditions, and production methods including application of fungicides and irrigation. Diseased samples were collected from Edmonton, Lacombe, and Taber area potato fields for isolation of *A. solani* cultures. Pure cultures are being maintained for *in vitro*, greenhouse, and field studies.

A disease of hemp

Hemp (*Cannabis sativa* L.) is a herbaceous annual grown mainly for its blast fiber and seed oil. In 1999, Health Canada issued licenses to plant 12,145 ha of hemp in Canada. Of these, 730 ha were in Alberta. In the last week of August, hemp plants (cv. Fasamo) in a central Alberta field showed the following symptoms and signs: wilting foliage turning light brown; dry tan to gray lesions on stems; shredding and breaking of stems at the lesion; presence of white mycelium in the lesion; and black round, irregular or oblong sclerotia (up to 5 mm in dia. and 2 to 11 mm in length) present externally at the lesion on the stem and inside the pith cavity. The lesions were found at the crown, near the inflorescence and along the entire stem length. Incidence of the disease in a survey of six commercial fields (40 ha) ranged from 1-8%. The organism isolated from the lesions produced characteristics of *Sclerotinia sclerotiorum*. Pathogenicity was confirmed and this is the first report of *S. sclerotiorum* on hemp in Alberta, Canada. The disease known as hemp canker has been reported to cause severe losses under cool wet conditions in the Netherlands.

Susceptibility of potato cultivars to various diseases

Progeny tubers of twenty cultivars from a replicated experiment were examined for comparative susceptibility to three soil-borne pathogens *Spongospora subterranea* (powdery scab), *Rhizoctonia solani* (rhizoctonia canker), and *Helminthosporium solani* (silver scurf). The experiment was conducted using the natural inocula of the pathogens. The cultivars showed differential susceptibility responses to the pathogens.

Early blight of potatoes

Large number of samples of *Alternaria solani* were induced sporulation for long term sporulation and future experiments.

Technology Transfer Services

Information on disease control was provided by presentations at industry meetings, farm visits, and by telephone. In addition, the research results were published in project research reports, industry newsletters, and scientific papers. The program leader P. Bains, attended many industry and scientific meetings and workshops including Potato Growers of Alberta annual, area, breakfast, and Potato Team meetings; Alberta Horticultural Congress; Fruit Growers Society of Alberta Berry School; annual meeting of the Plant Pathology Society of Alberta; Novartis Potato Seminar, Potato Seed Treatment Symposium; and International Plant Protection Congress.

Potato Agronomy and Varietal Development Program

C. Schaupmeyer and C. Feth

The objectives of the potato program are to assist in the selection and development of improved potato cultivars and to establish methods for improving quality and maximizing economic yields in Alberta's potato industry. These objectives are accomplished through research and technology transfer.

Research Projects

Potato cultivar improvement

Crop Diversification Centre South (CDCS) at Brooks is one of five cooperative tests sites in the Prairie Potato Breeding Program. The program is managed by the Agriculture Canada potato breeder, Dr. Dermot Lynch, who makes crosses at the Lethbridge Research Centre and makes preliminary selections at the Vauxhall substation. Final testing is done at the regional sites. Performance of test lines in the regional trials is evaluated by the breeder, test site cooperators, and industry staff.

The primary objective of the breeding program is to select improved potato varieties adapted to the southern prairies. Varieties needed by the industry include a chipping variety that is more stable in long-term storage; an early chipping variety that will yield well and chip by the third week in July; an attractive fresh-market red potato that holds colour in long-term storage; a maincrop fresh-market and French fry netted potato that is earlier than Russet Burbank and has better quality.

CDCS participates in cultivar evaluation in several ways. First, as a cooperator in the Prairie Regional Potato Trials, four cultivar evaluation trials containing about 400 lines are planted and managed. Second, the program produces some of the seed for the five regional trial sites in the Prairies. Third, there is participation with industry in the evaluation of advanced cultivars that have graduated from the regional trials.

Prairie potato regional trials

Approximately 400 lines were grown in four Regional Trials at Brooks. Data were collected on 30 to 40 agronomic and quality factors including yield, maturity, specific gravity, culinary and processing quality. Data from these trials were sent to Dr. Dermot Lynch at the Agriculture Canada Research Station in Lethbridge for analysis and summarization for the Prairie Potato Breeding and Selection Committee.

Alberta potato industry cultivar evaluation

Potato industry cultivar trials are continuing to evolve. The trials were originally established to evaluate (on a commercial scale) new potato cultivars that have graduated from the Prairie Potato Regional Trials. The trials enabled growers and processors to gain first-hand experience with new cultivars in the field and processing plant. Six years ago the Prairie Potato Breeding Consortium was established and responsibilities for industry evaluation are evolving. The consortium is a corporation funded by membership fees paid by five groups (processors, grower-owned companies, and grower organizations) from the three prairie provinces. Fees are used to pay for research studies directly related to consortium varieties.

Breeding lines entering the registration trials in the Prairie Potato Breeding Program are available for tendering to consortium members. The first tendering process started in late 1995. Successful bidders were assigned either exclusive rights or non-exclusive rights and were authorized to control the production of seed. They are required to pay a royalty to the consortium for the right of ownership. The owners of consortium varieties are responsible for market development of the varieties thus reducing the role of CDCS in this process.

In 1999, CDCS increased seed of 36 consortium varieties for trials in 1999.

Potato cultural research

Effects of in-row spacing on yield and quality of potato selections

Ten cultivars and advanced lines from the regional trials were planted at three in-row spacings in four replicates in a randomized complete block design. The cultivars/lines planted were Snowden, V0299-4, V0024-6, AV82101-12, ACLR Russet Burbank, Russet Burbank, V0379-2, AV81292-2, V0168-3 and V0266-8. The in-row spacings were 22 cm, 28 cm and 40 cm. Yield, size distribution and quality data were measured.

Technology Transfer Services

The program agronomist, C. Schaupmeyer, provides extension service to growers and industry personnel through direct contact, newsletters and factsheets, and presentations at conferences and workshops. In 1993, the program agronomist started a series of extension meetings with growers in Southern Alberta. These were continued again in 1999 in cooperation with the Potato Growers of Alberta. Seven meetings were held in Taber from April through November. Growers, industry staff, and research and extension staff attend these meetings and discuss production management. Attendance at each meeting during the past year was from 80 to 100 growers and industry staff in Taber. In total, approximately 600 growers and industry staff attended these informal extension/production meetings in 1999.

In 1999, one multi-national potato processing company (Lamb-Weston) started operation of their new frozen french fry processing plant east of Taber. The $100 million plant will be at full capacity in 2000 and require 180,000 tonnes of raw potatoes annually. In 1999, McCain Foods (Canada), Ltd. started construction of a similar plant east of Coaldale. When the plant is at full capacity in 2001 it will require 200,000 tonnes of raw potatoes. The two plants will require about 9,000 to 10,000 ha of potatoes.

These companies are locating in southern Alberta because of the high processing quality of processing potatoes grown here. In the past decade potato producers have increased the productivity by improving seed quality, cutting and planting management, and fertility management. These improvements are a result (in part) of agronomy studies conducted in the CDCS potato program in the past decade, and a result of the aggressive extension activities by program staff.

Seed Potato Program

P. Duplessis, T. Lewis, L. Maskewich and K. Andrew

The main objective of the seed potato program at the Crop Diversification Centre North (CDCN) is to provide support to seed potato growers throughout Alberta. This is accomplished through research trials and extension services. The program works closely with the Alberta Seed Potato Growers Association to ensure the needs of the industry are being met.

Seed potato repository. The purpose of AAFRD's seed potato repository is to maintain a collection of disease-free cultivars and lines to ensure the Alberta seed potato industry has a source of plants for nuclear production. This is accomplished by multiplying disease-tested stock plants for private labs. In 1999, 32 public potato cultivars and accessions and 10 private cultivars were distributed to private laboratories across the Western Provinces for multiplication. Plant Breeders' Rights issues are becoming increasingly important and complicated in the Potato Industry and program staff have worked closely with private breeders, their agents and Alberta Seed Potato Inc. to ensure that new varieties remain eligible for protected status.

Potato spindle tuber viroid (PSTV) sampling. In 1999 a potato spindle tuber viroid sampling program was initiated in Alberta. The purpose of the program was to prove that the potato producing areas of Alberta are free of PSTV and therefore make them eligible for European Union Zone status. Samples were collected from seed farms across the province and samples submitted to the Centre of Expertise for Regulated Potato Diseases in Charlottetown, PEI. The project was funded through the cooperation of AAFRD, Alberta Seed Potato Growers Association, Canadian Food Inspection Agency and Agriculture and Agri-Food Canada. All samples submitted tested negative for PSTV.

Research Projects

Potato microtubers in seed potato production in Alberta

A two year trial done in cooperation with K. Pruski, entomologist, CDCN was completed in 1999. The project was designed to evaluate the potential role of microtubers in Alberta's seed production system and included laboratory, greenhouse and field components. The cultivars studied in 1999 were Ranger Russet, Umatilla Russet and Russet Burbank. These varieties were selected because of their importance to Alberta's seed potato industry.

Microtubers were produced in an aseptic *in vitro* laboratory environment. The treatments were a control, a pre-treatment of jasmonic acid and jasmonic acid added to traditional media combined with lighting regimes of either 4 or 8 hours of light per day. Russet Burbank responded most favourably to *in vitro* tuberization. Tubers were counted, weighed individually and diameter measured, then sorted and treated with either gibberellic acid or rhindite to break dormancy for planting in field and greenhouse trials. Dormancy breaking results were improved in 1999 due to both a longer period of cold storage and improved dormancy breaking treatments.

A final report on this trial will be available in 2000.

Gibberellic acid trial

The second year of a gibberellic acid seed piece treatment trial was completed in 1999. The desired outcome of this study is to have the product Activol registered for use on seed potato tubers. Seed growers across the province have expressed interest in the use of gibberellic acid (GA) to increase tuber number and decrease average tuber size. This is common practice in the U.S., but no products are currently registered for use in Canada. The cooperation of Lewis Farms (Ranger Russet, Shepody, FL 1533 and FL 1833 seed), Norbest Farms Ltd. (Yukon Gold seed), and Norac Concepts (Activol) enabled the second replicated field trial in 1999.

The trial included an untreated control and a 5 ppm and 10 ppm GA solution made from Activol for each cultivar tested. Solutions were applied as a seed treatment which was sprayed onto tubers the morning prior to planting. A similar trial was conducted in New Brunswick by the New Brunswick Department of Agriculture.

Final analysis of the results has yet to be completed but looks promising. Future trials involving GA and seed piece spacing are currently being proposed.

Variety demonstration trial

Potato varieties and selections maintained in our repository are grown in the greenhouse on an annual basis. This ensures the lines remain pure and productive. Nuclear tubers produced at this facility are planted in the field for assessment of 'trueness to type'. Evaluation of potato cultivars is necessary to ensure the seed potato industry is provided with a high-quality seed source. This past year, the plot included 75 cultivars. Growers visited the plot during the Regional Trial tour and took the opportunity to look at the many cultivars that are in the repository. Visitors from Mexico were also interested in the demonstration trial as they were looking at chipping varieties which may be worth testing under their growing conditions.

Prairie regional trials — early and main crop replicated trials

These trials are conducted annually in cooperation with the Lethbridge Research Station. They are an integral part of the AAFC Potato Breeding Program. New cultivars and accessions are compared with well-known standards to assess performance, maturity, yield, specific gravity, culinary and processing quality. The observations are used to select new potato cultivars for the prairies.

CDCN was an early and main crop trial site in 1999 and an irrigated and dryland demonstration trial site for 19 advanced selections and 8 industry standards. The early crop trial included 6 breeding lines and Atlantic, Carlton, Norland and Russet Norkotah as standards. The main crop trial included 18 breeding selections for evaluation. Norland, Russet Burbank, Ranger Russet, Russet Norkotah, Shepody, Atlantic and Snowden served as standards. Growers had the opportunity to tour the site on August 18, Dr. Dermot Lynch of AAFC was on hand to answer questions about the advanced selections.

Technology Transfer Services

The seed potato specialist, P. Duplessis, co-organized the following seminars/ workshops:

- Tissue Culture Course — for training growers in tissue culture and greenhouse production of woody plants and potatoes at CDCN.
- New grower workshop, February 16th, Taber, AB.
- CDCN Field Day and Grower Tour

Participated in meetings and conferences:

- Washington Potato Conference and Trade Fair, Moses Lake, WA
- Area meetings of the Potato Growers of Alberta
- PGA Annual Meeting, Red Deer, AB

The seed potato specialist provided extension services to growers and industry personnel through direct contact and presentations at meetings and conferences. P. Duplessis also acted as a liaison with the Canadian Food Inspection to keep growers informed of regulatory changes.

Vegetable Crops Program (Brooks)

P. Ragan and W. Johnson

Applied field research and extension activities are designed to serve market gardeners, large-scale fresh vegetable growers, and contract processing growers.

Variety adaptation and earliness enhancement of crops through improvements in cultural management practices are the main research activities of the vegetable program. Technology transfer is carried out through on-farm visits, publications and participation in commodity organization conferences and workshops.

Research Projects

Variety adaptation

Approximately 400 varieties of 12 types of vegetables were evaluated. In addition, succession plantings of direct seed and transplant cauliflower and broccoli varieties were evaluated. Storage quality observations on all cabbage and onion varieties continued up to 6 months after harvesting.

Detailed results of varieties tested were reported in CDCS Pamphlet 2000-5 *Vegetable Variety Adaptation Trials 1999*. Copies were supplied to 30 participating seed companies. Workshops were held across the province in December to discuss findings and make recommendations to producers. These workshops also provided opportunities for producers to suggest priority areas for future research.

Production management trials

Detailed results of production management trials, along with summaries were reported in the CDCS Pamphlet 2000-4 *Vegetable Production Trials 1999*. A brief description of these trials follows.

Celery early market production enhancement

Celery is a long season crop that requires rapid growth and tolerance to low temperature in order to reach marketable size in Alberta. This randomized complete block trial investigated how six varieties in plugs #72 and #128 responded to an April 19 field planting, a full one month earlier than is commercially recommended.

Critical temperature below 5°C which cause bolting in celery occurred on 10 days in April and 19 days in May. Freezing temperatures occurred on seven of these days. The result was extensive bolting in all treatments so no harvesting took place. No single variety performed well.

Cauliflower supply continuity through planting schedule design

Harvest data and its relationship to seven planting dates and the mean monthly temperature over a six year period were analysed to design a reliable planting schedule for cauliflower industry standards. Data from four varieties revealed that any planting schedule designed must be variety specific. Beginning in late April and ending in late June with the seventh planting, the number of days separating successive plantings within a variety is determined by its mean temperature requirements to reach maturity. Early varieties have a lower mean temperature requirement than do mid-season varieties and designing a planting schedule for these varieties is less reliable when temperatures rise above normal.

Line spacing influence on early carrot root sizing and yield

In both 1998 and 1999 trials, all carrot variety industry standards were direct seeded using the Stanhay Mark II drill equipped with coulters 2.5 and 4.0 inches wide. Twin line seeded rows were hand thinned to 12, 15, 18 and 24 plants per linear foot. At an early harvest made 90 days after seeding, plants in all treatments (coulter width x plant density) were harvested, topped, washed and graded for yield of #1 roots measuring ¾ to 1¼ inch in diameter. All treatments were not replicated.

In all plant density treatments, the 4.0 inch wide coulter produced the highest yield of #1 grade roots. Yield increase ranged from 3 to 70 percent. Lowest plant densities recorded the highest yield increase at the 4.0 inch wide coulter treatment although this response was highly variety dependent. In measuring treatment (coulter width x plant density) effects on root length, no clear response was recorded in any variety.

Nitrogen and phosphorus rate influence on garlic production

This trial investigated the effects of fall broadcast application of nitrogen and phosphorus on the yield and bulb size of garlic. A simple randomized complete block trial was used with the following treatments:

Variety: Laszlo, soft-necked artichoke type and Vernon, a hard-necked continental type.

Fertilizer: nitrogen and phosphorus per acre interaction treatments of 100 x 200, 200 x 400, 300 x 200, 100 x 400.

This trial showed that garlic is not very responsive to nitrogen and phosphorous. Perhaps soil nutrient reserves were already adequate (N 44 and P 164). Although yield and bulb quality was not influenced when both nitrogen and phosphorous were applied together in early spring, sidedress application at planting will be investigated next season.

Technology Transfer Services

A one-to-one, on-farm extension service was provided to producers in the southern region of the province. Specialized equipment was loaned to producers to encourage adoption of new technology. Popular items included: two precision drills, transplanters and plasticulture equipment. Program staff also provided a seed belt punching and calibration service for producers using Stanhay seeders. Seed lots are matched with the best combination of belt hole size and number of holes to ensure optimum plant density in the field.

Annual workshops for vegetable producers were given to provide variety recommendations and guidelines to data interpretation as reported in the CDCS Pamphlets 2000-4 and 2000-5. These workshops also provided an opportunity for growers to comment on the direction of research programs.

Special activities included:

- Carrot field day at CDCS, for producers.
- Produce shipments to Calgary to assess market opportunities to the wholesale level.
- Tour of vegetable research plots at CDCS by seed company reps.
- Supply chain linkages between growers and produce buyers were established for the 1998 season.

The *Processing Vegetable Growers Newsletter* was edited and posted quarterly.

Vegetable Crops Program (Edmonton)

B. Choban and C. McIsaac

The vegetable program at CDCN provides the vegetable growers in north and central Alberta with extension and applied field research that responds to growers' needs, current market demand and the industry's development and growth. The ultimate aim is to increase the skills and knowledge of vegetable producers so they can become more competitive, increase their farm income and develop a self-reliant industry.

Research Projects

Research was concentrated on variety evaluation, crop diversification and production management, and was aimed at enhancing crop maturity, improving product quality and increasing yields for commercial vegetable crops grown in Central Alberta. Most seeds were donated by various seed companies. Funding to support a part-time summer labour position came from private producers. A detailed research trial report is available on request by contacting CDCN for report CDCN #99-V09, 1999 Vegetable Research Report—Field Trials. Workshops were held in December with industry to share trial results and to discuss research priorities for next year.

Colored Plastic Mulch Observation Trial with Sweet Corn — Corn grown in plastic mulch regardless of color, produced earlier maturing cobs and higher yields than corn grown in un mulched, bare soil. Clear plastic mulch was the best for soil warming but encouraged too much weed growth. Red plastic mulch had the greatest positive influence on plant growth, yields, maturity and quality.

Integrated Pest Management Approach in Control of Root Maggots in Cabbage Crops — This is an on going trial and is being done jointly with the Entomologist, Kris Pruski at CDCN. Alternative and effective treatments are being sought for root maggot control in cabbage. A second year of studies was completed. The project was funded by industry and matched with AARI funds. Tiger 90 was not effective in the 1998 trial, so was dropped from the 1999 trial. Entompathogenic fungus *(Beauvaria bassiana)* treatment was added to the 1999 trial. It produced satisfactory results. Garlic barrier (an organic insecticide control) tended to repel the insect. The Larvanem (nematode 100,000 per plant) treatment showed overall results that were close to the Lorsban 4E treatment.

The data suggests that besides the regular chemical insecticide treatment, the alternatives such as Garlic Barrier, entomopathogenic fungus and nematodes can be used effectively. However, more trial work is necessary to determine the effectiveness, method of application and timing.

Carrot Density Trial — Four different plant densities for three different varieties were evaluated for early sizing, quality and yields. Plant densities consisted of the following: (#1) twin line, 90-90 Stan Hay seed belt with 3" coulter and plants thinned to 30 plants per linear foot. (#2) same as (#1) but plants thinned to 25/ft. (#3) triple line, 90-72-90 Stan Hay seed belt with 4" coulter and plants thinned to 30 plants per linear foot. (#4) same as (#3) but plants thinned to 25/ft. The early maturing variety, Special Nantes 616 (a Nantes type) produced the earliest and highest yields of excellent quality from the most densely planted population trial (#1). The mid season maturing variety, Nevis (a Nantes x Imperator type) produced the earliest and best yields from its second most densely planted population trial (# 2). The late season maturing variety, Ivanhoe (an Imperator type) produced the earliest and best yields from the second least densely planted trial (#3).

Carrot Varieties — 27 varieties and two harvests (early and late season). New mid season excellent performing varieties were Idaho (a short carrot good for direct marketing), HM02 (good carrot for cello market) and Fontana (a good carrot for early jumbo market). New late season excellent performing varieties were Napa and Navarino. Both were long carrots, excellent for cut and peel market.

Mid Season Cabbage Varieties — 31 varieties. Transplants used. The industry standard Parel was still the earliest maturing of excellent quality with up to one week of field keeping quality before head splitting. The new variety Atlantis matured early to mid season with excellent quality, yields and 19 days to first head splitting. This variety had soft, pliable leaves and made excellent cabbage rolls that compared to those made from a back yard garden variety called Copenhagen. Cecil was still an excellent all-round variety for mid season harvest. Heads were round, solid and dense, nice for shredding. Interior was white, a nice colour for kraut. Leaves when well blanched were good for cabbage rolls. Huron was a late maturing variety with better storage potential. Because of its dryness, it was the preferred variety for spring roll fillings.

Mid Season Cabbage Storage — 23 varieties. Most varieties stored well up to 1 2/3 months. After two months many varieties lost colour and more than 10% of their weight. Genesee and Rona Red, closely followed by Survivor and Emblem performed the best. In the consecutive variety stated above, they reached close to 10% weight loss after 16 weeks (3 2/3 months) and 10% weight loss after 13 weeks (3 months).

Broccoli Planting Schedule — Three varieties (early, mid and late season types) were used and succession direct seeded six times, starting May 6 and ending July 19. Successful harvests occurred from all plantings done prior to July 1st. A continuous harvest was achieved when each succession seeding was done immediately after the seeds germinated from the previous seeded trial. First harvest started at the end of July and continued to the end of September. With an earlier spring start-up and a longer warm fall, this harvest period could easily start 1 week earlier and end one week later.

Broccoli Varieties and Succession Seeding — 19 varieties and 4 consecutive seeding dates. The new varieties Monterey, Lucky and Triathlon looked very good for late-early to mid season maturity.

Cauliflower Varieties and Succession Seeding — 18 varieties and 3 transplanting dates. The new variety Idol compared with Pathfinder in early maturity but had light weight heads. The industry standards Minuteman and Rushmore performed well all

season, as did Siria and Fremont for early to mid season, and Amazing, Iceman and Cumberland for mid season, and Lateman for late season. The new varieties Chieftan (for early to mid season) and Apex (only for late season) looked promising.

Rutabaga Varieties and Storage — Four varieties. The new, white fleshed and white skinned variety Gilfeather out performed the industry standard Laurentian in quality, yields and storage keeping qualities.

Turnip Varieties — Four varieties. White Lady produced the highest yields and was the earliest to mature. It was closely followed by Purple Top White Globe and then Hakurel (the best tasting).

Radish Varieties and Succession Seeding — Five varieties and six succession seeding dates. Two new varieties from Stokes, SPA 3503 and SRA 1501 looked very promising. Both produced excellent quality, round, crisp, crunchy, red radishes throughout the growing season. These varieties did not bolt in the mid summer heat and produced successful harvest from all plantings done up to late July. A continuous harvest occurred when each succession seeding was done immediately after the seeds germinated from the previous seeded trial.

Garlic Varieties — 14 varieties. Fall planted (Oct. 1), no straw mulch, had good snow cover. Siberia continues to out-perform other varieties. It was closely followed by Laslow, Legacy and Music.

Onion—Transplant vs Direct Seed Trial

Cooking onions — Five varieties. All transplants matured and had good quality and high yields. But only two varieties matured from the direct seeded trial, these being a new variety called Spectrum and the industry standard, Norstar. The new variety Millennium matured 100% when transplanted. Yields were high and Quality was good.

Spanish onions — Three varieties. All transplants matured with excellent quality verses none maturing from direct seed. The new variety called Vision produced outstanding yields as a transplant.

Other onions — Four varieties of pickling onions, mini and green onions. All direct seeded varieties took double the time (or longer) to mature than the transplanted varieties.

Snow Peas Varieties — The new variety Yuhsaya, produced excellent quality with higher yields than the industry standard Little Sweetie, but matured 3 to 6 days later.

Zucchini Varieties — Three new varieties. All performed well. JSS 9601 (Johnny's) was dark shinny green, smooth skin, long, uniform in shape and very attractive. Tromboncino (West Coast), an Italian type, was light green, long, slender, unattractive crookneck shape but with an appealing, somewhat sweet taste. Eight Ball (Stokes) was a nice small round novelty type that split easily if allowed to over-size.

Specialty Vegetable Varieties — The following new or untested varieties performed well: Suey Choi varieties Cha Cha and New Wind; Bok Choi variety Fen Quing Choi; Chinese Broccoli variety Guy Lon; Mustard Greens varieties Autumn Poem and Bouquet; Savoy Cabbage variety Kilosa; plus Swiss Chard varieties Bright Lights and Bright Yellow.

Other Vegetable Varieties — Varieties in winter squash, field tomatoes, field peppers and watermelon showed very poor results due to cool wet unfavorable growing conditions throughout most of the growing season.

Asparagus Varieties — Nine varieties, perennials. Trial was started during the 1999 growing season and will become established over the next two years.

Rhubarb Varieties — Several varieties were propagated and grown in pots during the 1999 growing season. They will be field set this season. More variety entrance are being sought.

Technology Transfer Services

Transfer of technology and information was provided to growers and industry through direct contact, seminars, presentations at tours, field days, meetings, courses, conferences, extension publications and newsletter articles. On-farm consultation continued on an as-needed basis. Diagnostic problem solving, soil fertility recommendations and specialized equipment demonstration was maintained.

Liaison continued with Alberta Market Gardeners Association (AMGA), commercial seed companies, Alberta Horticultural Congress and other industry personnel. AMGA sponsor an out-of-province direct market conference trip for the specialist.

Maintained contact with the produce marketing industry for exchange of information and keeping informed on current market and consumer trends. Kept informed by attending Canadian Produce Marketing Association Trade Show and meetings, and through Fall Harvest Festival activities that promote the production of fresh vegetables to the public. Also kept buyers informed on local crop status and product availability through contribution made in a weekly and by-weekly crop report bulletin distributed by the department.

Provided information to the department in areas that help contribute to the growth and development of the vegetable industry. Priority areas included action plans that the Horticulture Product Team addressed, reviewing loan proposals for growers and financial institutes, providing consultation and advice on crop diversification and direct marketing for rural development and business development specialists and by doing various talks to Agriculture service boards on vegetable production.

New Crop Development Unit

Dr. Stan Blade, Unit Leader

The mission of the New Crop Development Unit (NCDU) is to ensure that applied research, industry development and technology transfer activities are appropriately channelled to support the special crop industries in Alberta. This is consistent with the market-driven thrust of Alberta Agriculture, Food & Rural Development (AAFRD) programs and also fosters sustainable agricultural production. NCDU clients include primary producers, commodity organizations, agribusiness, food processing companies, Agriculture and Agri-Food Canada personnel, university scientists and other specialists, both within and out-of-province. The NCDU exists to promote and support crop diversification and value-added initiatives in Alberta.

The New Crop Development Unit is one of five work units within the Plant Industry Division (PID) of Alberta Agriculture, Food and Rural Development.

The primary mandate of the NCDU is to promote crop diversification, particularly with specialty field crops. The area devoted to the production of these crops in the province in 1998 was approximately 850,000 acres and it consisted of the following major crops: field pea 530,000 ac, mustard 145,000 ac, drybean 45,000 ac, lentil 25,000 ac and sugarbeet 45,000 ac. The remaining acreage was made up of grain corn, safflower, sunflower, fababean, canary seed, wild rice, spearmint, peppermint and a number of other small acreage crops. The estimated farm gate value for special crops in Alberta in 1998 exceeded $140 million.

Special crops are defined as alternative or non-traditional crops that generally are grown on small acreages, often under contract, and usually outside the control of the Canadian Wheat Board. This definition is not bound by acreage, and it is recognized that crops designated as "special crops" will change over time. Some examples of special crops currently being grown on a commercial scale in Alberta include buckwheat, canary seed, caraway, chickpeas, coriander, corn, dill, dry bean, faba bean, field pea, chickpea, low-THC hemp, ginseng, lentil, medicinal plants, mustard, peppermint, safflower, spearmint, sugarbeet, sunflower, wild rice, and miscellaneous herbs and spices. NCDU programs encompass all of these crops, with emphasis on those of greatest economic importance.

Most special crops are produced under contract or for direct marketing, and much of Alberta's production is exported. There is considerable value-added processing of crops such as mustard, sugar beet and herbs and spices. Others, such as sunflower, lend themselves to consumer marketing. The value of processed special crops in Alberta has not been established.

The NCDU receives strategic direction directly from the crop and processing industries it serves, as well as from commodity organizations, e.g. the Alberta Pulse Growers Commission and the Alberta Special Crop, Horticulture and Forage Product Teams. All programs in the Unit are reviewed every three years by scientific colleagues and industry representatives, including producers, processors and agribusinesses.

The following programs currently comprise the NCDU: administration, plant pathology, post-harvest technology, soil and water agronomy, special crops, and weed science. All of these programs are represented at the Crop Diversification Centre South (CDCS) at Brooks. In addition, there are NCDU staff at the Crop Diversification Centre North (CDCN) (special crops, farm team, administration and apiculture) in Edmonton, Fahler (apiculture) and the Beaverlodge Research Farm (special crops).

Apiculture Program

K. Tuckey and D. Colter

The apiculture section of Alberta Agriculture, Food and Rural Development provides extension and regulatory service to the beekeeping industry of Alberta. Offices are maintained in Edmonton and Falher.

Apiculture registrations 1999

The Alberta Bee Act requires people who own and possess honey bees or beekeeping equipment in Alberta to register, annually, the number of colonies they own and the municipalities in which their bees are located (Tables 1, 2 and 3). The large number of beekeepers shown in Regions 2 and 4 reflects, in part, the number of hobbyist beekeepers living in Calgary and Edmonton.

The relatively large number of colonies in Region 1 reflects the honey bee colonies needed to service the hybrid canola seed production industry in that area.

Table 1. Number of beekeepers and colonies.

Region*	1998		1999***	
	Beekeepers	Colonies	Beekeepers	Colonies
N R**	4	3409	6	4213
1	74	53950	72	52831
2	151	12065	155	16247
3	100	26428	102	28154
4	276	55732	264	55203
5	123	53593	109	55503
Total	728	205177	708	212151

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1999

Table 2. Number of beekeepers — by region and size of operation.

Colonies operated	Number of beekeepers per region* 1999***						
	NR**	1	2	3	4	5	Total
0	-	12	33	13	47	7	112
1-50	2	39	96	59	153	39	388
51-600	1	10	20	14	42	31	118
601+	3	11	6	16	22	32	90
Total	6	72	155	102	264	109	708

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1999

Table 3. Bee colonies operated — by region and size of operation.

Size of operation	Number of colonies per region* 1999**						
	NR**	1	2	3	4	5	Total
1-50	13	485	869	578	1507	506	3958
51-100	100	154	435	151	1318	778	2936
101-200	-	222	1009	600	1157	1188	4176
201-600	-	2480	2394	2578	7311	5299	20062
601-1250	700	2390	625	6870	9482	19896	39963
1251-2000	3400	1800	4915	7281	7108	6380	30884
>2000	-	45300	6000	10096	27320	21456	110172
Total	4213	52831	16247	28154	55203	55503	212151

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1999

Alberta beekeepers placed those 212,000 colonies in 6,568 beeyards or apiaries. Most of these beeyards are on land owned by someone other than the beekeepers and in most cases the landowners receive a "rent" of about 30 pounds of honey for the inconvenience of having bees on their property.

Economics of beekeeping

The price of raw bulk honey reached a record high of about $1.25/lb in 1996. By December 1999 this price declined to about $.70/pound. Sales of Alberta honey are being pressured by the movement of Argentine honey into the USA and the European concern over genetically modified organisms (GMO). Much of Alberta's honey comes from hybrid canola plants that are GMO and honey gets caught in the controversy.

The demands of the hybrid canola seed production industry in southern Alberta continue to exercise a major influence on Alberta beekeeping. In 1999 at least 55,000 colonies were devoted to hybrid canola seed production. This is reflected in the tables above which shows a small number of beekeepers and a very large number of colonies in Region 1. As demand for honey bees increases, beekeepers from further afield are being attracted to this venture. It is known these colonies will produce a very small honey crop — about 20% of the provincial average. The rental rate for these colonies stays competitive with the normal returns from honey production. It appears there will be little demand for more colonies for 2000.

Alberta honey production 1999

In a direct contrast to 1998 there was only one area of the province with conditions that provided a good honey crop. The survivability over the winter was down somewhat from 1997-98. A mild winter led to a cold wet spring that retarded the development of honey bee colonies and slowed the growth of honey plants. Once the honey flow started most of the province experienced dry weather that severely reduced the honey crop. The good weather during the autumn allowed the bee colonies to be in good shape as they entered the winter.

As mentioned above the bees on canola pollination produce little honey and the honey production over the rest of the province was affected by the dry weather. It appears that the 1999 Alberta average honey crop will be about 100 pounds per colony for a total crop of 21,000,000 pounds.

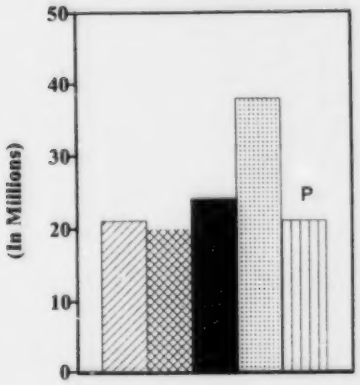

Fig. 1. Honey Production (millions of pounds)

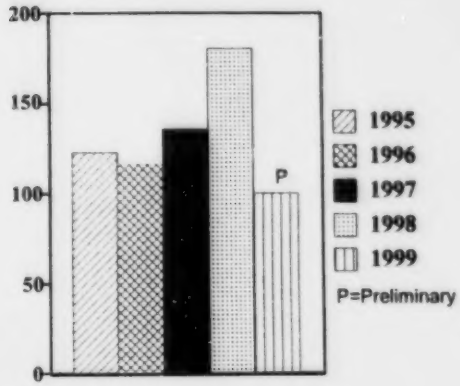

Fig. 2. Average Honey Yield (pounds/colony)

Apiculture inspections and surveys

As varroa mites are found in more beekeeping operations, beekeepers are becoming more aware of the need to test their own bees for the presence of parasitic mites. The original Alberta varroa mite findings (1993 & 1994) were in operations that received honey bees directly from British Columbia. Since 1995 varroa mites have been established in the permanent bee population. The spread of varroa continued in 1999.

By the end of 1999 varroa mites had been identified in 100 beekeeping operations in 55 rural Alberta municipalities. Those 100 beekeepers operate approximately 122,000 colonies. However, not all bee colonies in each of those operations or municipalities, nor even most of them, are positive for varroa. Varroa mites have been identified through most of the province except for the St. Paul area and the east side of the province almost as far south as Medicine Hat.

Honey Bee Tracheal Mites are known to be in 200 operations covering roughly the same part of the province as the varroa mites.

Most hive inspections carried out were at the request of owners — either to facilitate the sale of equipment or because the beekeeper perceived a problem. Colonies and/or equipment in 15 beekeeping operations were examined specifically for brood diseases. American Foulbrood (a bacterial disease) was detected in eight operations. The inspections were not widespread enough to give an indication of the health of the whole industry. However, it is clear that beekeepers who do not monitor and control this disease can have a problem develop quickly.

Interprovincial movement of honey bees

A permit is required from Alberta Agriculture, Food and Rural Development to move Canadian honey bees into Alberta. Also regulations require all bees coming into Alberta from provinces known to have varroa mites must be treated for the control of the mite prior to entry. A number of shipments were checked to confirm compliance with this regulation.

During the spring of 1999 permits were issued for the importation of 14,700 colony units (packages, nucleus or full size colonies) into Alberta from British Columbia. About 2,500 of those colonies came to Alberta specifically to pollinate hybrid canola.

Overwintering honey bees

Alberta beekeepers continue to winter their honey bees in British Columbia, in ventilation controlled buildings or outdoors. Bees are wintered in a number of formats. The most common way is as two brood chamber colonies outdoors but a few beekeepers utilize three supers outside. Bees that are wintered indoors or in British Columbia may be one or two brood chamber colonies or nucleus colonies (nucs) with only five or six frames. Table 4 provides wintering statistics for recent years.

Table 4. Winter survival of honey bee colonies.

Year	Colonies operated *	Units into winter	% Survival
1994-1995	166000	161000	81
1995-1996	180000	174000	69
1996-1997	164000	In 64,000	82
		Out 102,000	80
1997-1998	174000	In 55,000	87
		Out 117,000	89
1998-1999	205000	In 64,000	83
		Out 133,000	83
1999-2000	212,000#	202,000#	N/A

* indicates the number of colonies operated prior to the winter
# estimate

Government Programs

Agriculture Financial Services Corporation-Insurance Division

This joint Federal, Provincial and industry program continued to protect 33 Alberta beekeepers with 48,000 colonies from losses due to poor honey yields compared to their long-term average yield. Eighteen beekeepers made claims totalling $885,000 against the program. This program has experienced significant losses for several years in a row and is currently being reviewed.

Net Income Stabilization Account (NISA)

This joint Federal, Provincial and industry program, which assists farmers to provide long term monetary security for their farms, was first offered to beekeepers in the 1992 taxation year. Since then the programme has been very popular with beekeepers and 133 beekeepers made contributions on $14,700,000 of net honey sales for the 1998 year.

Farming For The Future and On Farm Demonstration Program

These provincially funded programs assist in basic and applied research and in proving the worth of new ideas on the farm. From time to time beekeeper related subjects are tested.

Statistics

Each year the Production Economics and Statistics Branch of Alberta Agriculture, Food and Rural Development does a survey of beekeepers to determine the amount of crop received and other data about the Alberta beekeeping industry. This information is forwarded to Statistics Canada and included in country-wide figures. As well the same section periodically collects data on the economics of the industry. These are published as Agdex # 821-62. The latest compilation was for the 1998 crop. For the first time the study looked at beekeepers involved in the hybrid canola pollination.

Canada-Alberta Farm Business Management Initiative

A profile on the "Commercial Honey Industry" was published in AgVentures Series, Agdex # 616/830-1 during 1998. It is still available and serves as a valuable resource for persons wanting to get into or expand commercial beekeeping.

Technology Transfer Services

Both apiculturists provide monthly articles to the *Bee News*, published by the Alberta Beekeepers' Association. Talks were given to the annual meeting of the Alberta Beekeepers' Association and to local beekeepers meetings upon request.

A large part of any summer office time is used providing advice to members of the public who have called with "honey bee" problems. At least half the time the insects involved are bumble bees or some type of wasp.

Beekeepers and potential beekeepers consult the apiculturists on a regular basis requesting information or service. E-mail is becoming a very important communication device to beekeepers. Twenty-seven per cent of the beekeepers provided e-mail addresses.

Interpreting the beekeeping industry to other segments of the government, and to industry, is an important facet of the duties of this section.

Plant Pathology Program

K.F. Chang, R.J. Howard, M.A. Briant, C.L. Bandura, M. Nielsen, T. Schick, D.A. Burke, and S.P. Huggons

The Plant Pathology Program has a mandate to conduct applied research on important diseases of horticultural, forage and specialty crops. This research encompasses field, laboratory, growth chamber and greenhouse experiments, as well as disease surveys. Findings from this work and from the research of other scientists are presented to commercial producers through technology transfer programs. The Plant Pathology Program also provides service in the form of support to crop production research programs at CDCS. Some plant pathology projects are also discussed in the report of the Post-Harvest Technology Program.

Research Projects

Diseases of special crops

Response of bean cultivars to bacterial halo blight

Twenty-three dry bean cultivars, comprising six market classes, were screened for resistance to *Pseudomonas syringae* pv. *phaseolicola* (*Psp*) under greenhouse conditions at CDCS Brooks and under field conditions at Bow Island and Brooks. Performance of these cultivars was similar at both sites. Two navy bean cultivars (AC Skipper, Upland) and a black bean cultivar (CDC Expresso) germinated very poorly and produced lower yields. Moderately resistant cultivars, such as Beryl, a Great Northern type, showed smaller foliar lesions after infection by *Psp* bacteria and some also generated higher yields than susceptible cultivars. Cultivars that showed resistance to halo blight under greenhouse conditions included: Beryl and US1140 (Great Northern), Pintoba and Pinray (Pinto), AC Alberta Pink (Pink), Ember and AC Earlired (Small Red), AC Harblack and CDC Nighthawk (Black), and AC Skipper (Navy). Cultivars which showed resistance to halo blight and produced the best yields at Brooks were: US1140 (Great Northern), UI114 and Maveric (Pinto), Viva (Pink), Ember (Small Red), Nighthawk (Black), and Upland (Navy). At Bow Island, US1140, Pintoba, AC Alberta Pink, Ember, and AC Earlired produced the highest yields.

Seed treatment and foliar application of Kocide LF to control halo blight of dry bean

Othello, a blight-susceptible pinto cultivar, was sown in a field trial at Bow Island in six treatments: a) inoculated seeds without foliar spray; b) with early foliar spray; c) early & late foliar sprays; d) with late spray; e) seed treated with Kocide (cupric hydroxide) and early and late foliar sprays, and f) clean seed without foliar sprays. There

were no significant differences between the treatments with respect to emergence, disease severity or yield. However, where inoculated seed was treated with Kocide, both emergence and seed yield were higher than for plants treated with foliar sprays alone. Disease incidence was higher on plants that were given only an early foliar spray with Kocide. The use of Kocide for seed treatment and applied as early and late foliar sprays provided the best control of halo blight under field conditions.

Comparison of fungicidal seed treatments for the control of fusarium, rhizoctonia and pythium root rot of chickpea

Three trials were set up in experimental plots at CDCS, Brooks to investigate fungicidal control of root rot diseases. Fungicides tested included Apron XL (3.75, 7.5 g ai), Apron XL + Maxim (7.5 + 2.5 g ai), Apron Maxx (3.75, 7.5 g ai), AMD (Apron-Maxim-Dividend; 7.5 +2.5 + 12 g ai/100 kg seed) + Adage (25, 50 g ai), AMD + Helix Green (200 g ai) and Vitaflo 280 (88 g ai). For fusarium root rot, all seed treatments except Apron XL increased emergence over the inoculated control. Combinations including Maxim or Apron Maxx all produced greater emergence than Apron XL, Vitaflo 280 or Maxim alone. All treatments, except the two rates of Apron XL, showed higher seed yield than the inoculated or non-inoculated controls. Treatments where Adage or Helix Green were included in the formulation had higher seed yields than those treatments without either of these products.

For pythium root rot control, all seed treatments, except Maxim alone, increased seedling emergence over the inoculated control. Apron, Apron Maxx and Maxim-Apron combinations improved emergence over both inoculated and non-inoculated controls, as well as over Maxim and Vitaflo 280. Seed yield was improved over the inoculated control by Apron XL at 7.5 g ai/100 kg seed, Apron Maxx at both rates (3.75 & 7.5 g ai/100 kg seed), and by all AMD combinations, except where Adage was included at the higher rate. Apron Maxx at the lower rate and the AMD combination alone, or in combination with Helix Green, also improved seed yield over Vitaflo 280 and Maxim alone.

For the control of rhizoctonia root rot, treatment with VITAFLO 280 and U2727 improved seedling emergence and seed yield over the inoculated control. Application of LO 176 did not improve either parameter over the non-treated control. Emergence levels were similar for both cultivars, but seed yield was greater for cv. Sanford than for cv. Tyson.

Evaluation of foliar fungicides for the control of ascochyta blight of lentil and field pea

Two field trials were established to control ascochyta blight on lentil and field pea. Treatments included BAS 500 at 0.1, 0.15 and 0.3 kg ai/ha, which were applied once or twice. Bravo Ultrex was included as a control fungicide. In the lentil trial, no differences were noted among spray treatments. Levels of ascochyta foliar blight were not great enough to measure, but application of Bravo Ultrex or BAS 500 applied as the second formulation, as a double spray at 0.1 kg ai/ha, or applied with a low water volume, resulted in greater seed yield than the untreated control.

For the field pea trial, all fungicide treatments reduced disease severity compared with the non-treated control at CDCS, Brooks and Mundare. No differences in disease severity were observed among treatments at Mundare, but the plots at Brooks that were sprayed twice with Bravo Ultrex, the highest application rate of BAS 500, or two sprays of BAS 500, showed significantly lower levels of disease severity than the single spray of BAS 500 at the lowest rate, the single spray of BAS 500 at the lower water volume, and the single spray of Bravo Ultrex. No significant differences in seed yield were observed among treatments.

Evaluation of fungicidal seed treatments to control rhizoctonia root rot of field pea

Vitaflo 280 (3.3 mL/kg seed), U2727 (4.0 mL) and LO 176 (1.25, 2.5 mL) were applied to seedlots of field pea cvs. Highlight and Carneval. All seed treatments

produced greater seedling emergence and seed yield than the inoculated control. Seedling emergence for the LO 176 treatments was lower than for Vitaflo 280 or U2727, and was lower for this treatment at the high versus low rate. Seed yield was greater for Vitaflo 280 than for the U2727 treatment, but neither treatment differed significantly from the LO 176 treatments. Highlight had greater seedling establishment and seed yield than Carneval.

Evaluation of fungicidal seed treatments to control rhizoctonia root rot of lentil

Vitaflo 280 and U2727 produced greater seedling emergence and seed yield than the inoculated control. Seedling emergence for the LO 176 treatments was lower than for Vitaflo or U2727. Both seedling emergence and seed yield were greater for Vitaflo 280 than U2727. Seedling emergence was greater for cv. Eston versus Laird.

Evaluation of fungicidal seed treatments for the control of pythium root rot of pea

In cooperation with Dr. S.F. Hwang and G. Turnbull, trials were set up at ARC, Vegreville to control pythium root rot of pea using fungicides. The Apron-Maxim-Dividend (AMD) combinations, where added to Adage (25, 50 g ai/kg seed) or Helix Green (200 g ai), improved seedling emergence over the inoculated control. Both Apron Maxx formulations, Apron XL at 3.75 g ai, and Apron XL + Maxim (7.5 + 2.5 g ai) also improved seedling emergence over the inoculated control. Treatment with Apron Maxx at 3.75 g ai or AMD with Helix Green (200 g ai) resulted in greater emergence than treatment with AMD alone. There were no significant differences in yield between treated and non-treated seed, or among seed treatments.

In another field study using Captan and Apron to control pythium root rot, all seed treatments increased emergence over both inoculated and non-inoculated controls. Captan + Apron at 280 + 110 mL/100 kg seed with CF Clear (60 mL/100 kg seed) improved emergence over CAPTAN (560 mL) alone, but not over any of the other treatments. All treatments had a lower root rot rating than the inoculated control, and were not significantly ($P<0.05$) different from the non-inoculated control. Nodulation was similar for all treatments and controls. Seed yield did not differ significantly among seed treatments, but was higher than the inoculated control for the Apron treatment alone, for Apron + Captan at the lower rate (280 + 110 mL), and for Apron + Captan + CF Clear at the higher rate (560 + 220 + 60 mL).

Evaluation of foliar spray formulations for the control of powdery mildew of field pea

Fungicide treatments included Tilt (62.5, 125 g ai/ha), Stratego (62.5, 125 g), Actigard (10 g), Flint (62.5 g) and Quadris (250 g) to control powdery mildew of field pea. All fungicide treatments, except Actigard, had significantly lower disease severity than the untreated control. Treatment with Tilt at 125 g or with Flint (62.5 g) resulted in lower powdery mildew ratings than any other treatments, except Stratego at 125 g. Seed yield was significantly higher for Quadris than for Tilt at 125 g or Stratego at 62.5 g.

Comparison of fungicidal seed treatments for the control of fusarium and pythium root rot of lentil

For fusarium root rot control, seed treatments that significantly ($P< 0.05$) increased emergence over the inoculated control included Maxim, Apron Maxx at the higher rate, and the AMD combination in conjunction with Adage at the higher rate or with Helix Green. Seed yield was improved over the inoculated control by the Apron-Maxim-Dividend (AMD) combination in conjunction with Adage at the higher rate or with Helix Green.

For the control of pythium root rot, the AMD combinations improved seedling emergence over the inoculated control where Adage or Helix Green were added. There were no differences between yield of treated and non-treated seed, or among seed treatments.

Evaluation of fungicidal seed treatments for the control of fusarium root rot of pea

All treatments, except Apron XL, significantly ($P < 0.05$) improved seedling emergence over the inoculated control. Both Apron Maxx formulations, Apron XL + Maxim and the AMD combination, where used with Adage at the lower rate or with Helix Green, improved seedling emergence over Vitaflo 280. There were no differences between yield of treated and non-treated seed, or among seed treatments.

Survey for ascochyta blight and root rot diseases of chickpea in southern Alberta

Eleven of 18 fields (867 ha) showed very little root rot. *Fusarium* spp. were the most prevalent microorganisms isolated from infected roots, followed by *Gliocladium* spp., *Alternaria* spp. and *Botrytis* spp. *Pythium* spp., *Sclerotinia sclerotiorum*, *Penicillium* spp. and *Aspergillus* spp. comprised a minor portion of the microorganisms isolated. Saprophytic nematodes and bacteria were also commonly isolated from the samples. The mean ascochyta blight severity was low.

Survey of aster yellows of echinacea in Alberta

Eight plantings of *Echinacea angustifolia* (*Ea*) and *E. purpurea* (*Ep*) were surveyed for aster yellows between early June and late September, 1999. At an experimental site at Brooks, all plants from 40 (1-yr-old *Ea*), 72 (1-yr-old *Ep*) and 28 (2-yr-old *Ea*) plots, respectively, were checked for the disease results. Aster yellows was found in all of the commercial fields surveyed. Disease incidence (DI) varied with location, age and species of the crop. For first-year *Ea* crops, the highest DI occurred at Clive and ranged from 2.0-8.0%, with an average of 3.4%. A 17% DI occurred in second-year *Ea* fields. The 0.9% DI in a field at Edmonton was an underestimate, since diseased plants has been eliminated from the field before the survey was done. The average DI of aster yellows on 1-year-old *Ep* was 21.7%, much higher than the DI observed on *Ea* crops of the same age. At Brooks, diseased plants were not removed from 1-yr-old *Ep* plots in 1998 and DI in these plots increased by 70% over 1998. These plots were plowed down in June 1999 to prevent the disease from spreading to newly established echinacea plots.

Occurrence of damping-off and root rot of echinacea in greenhouses of Alberta

Echinacea seedlings in five greenhouses were surveyed for damping-off and root rot from mid- to late April and these diseases were found at all locations surveyed. DI at the most severely infested location ranged from 3.1-35.2%, with a mean of 16.3%. Fungi belonging to five genera were isolated from infected roots. *Fusarium* spp. were the predominant microorganisms isolated from all greenhouses, followed by *Penicillium* spp., *Alternaria* spp., *Rhizopus* spp., *Pythium* spp. and saprophytic bacteria. *Fusarium oxysporum* was isolated from roots with discolored vascular bundles. *Alternaria* spp. were isolated from 40.9% of the root samples from one greenhouse. Control measures for these seedlings diseases are underway in some of these greenhouses.

The occurrence of alternaria leaf spot of *Echinacea* spp. and the effect of temperature regimes on disease development

Alternaria spp. infect leaves of *Echinacea angustifolia (Ea)*, *E. purpurea (Ep)*, *E. pallida (Epa)* causing small leaf spots which may coalesce to form large foliar lesions. Young shoots, floral stalks and flowering heads can also become infected, resulting in dieback. Using detached leaf assays, *Alternaria* isolates showed differential pathogenicity on leaves of *Ea*, *Ep* and *Epa* under temperature regimes of 30/20, 25/15 and 20/10°C (16/8 hr; day/night). Seeds of *Ea*, *Ep* and *Epa* showed various infection frequencies with *Alternaria* spp. Of 100 isolates of *Alternaria* spp. isolated from echinacea seeds, 80, 59 and 49% of them caused leaf lesions on *Ea*, *Ep* and *Epa*, respectively.

Chemical control of *Phytophthora cactorum* in ginseng under greenhouse conditions

P. cactorum cultures were incorporated into sterilized soil and were adjusted to low, medium and high inoculum concentrations. Treatments for each concentration were:

Check (inoculated & non-inoculated soil), Ridomil 1G (inoc. & non-inoc. soil) and Ridomil 2G (inoc. & non-inoc. soil). The fungicides were applied three times with the first application at seeding time and at six week intervals thereafter. Overall, ginseng seeds in the Ridomil 1G and 2G treatments had a significantly higher emergence rate than those of control treatment when soil had a low concentration of *P. cactorum*. However, Ridomil 1G and 2G did not increase emergence rates when soil contained medium and high concentration of fungal inoculum.

Fungicidal control of Sclerotinia stem and root rot on borage

Sclerotinia blight of borage caused by *S. sclerotiorum*, was found in experimental plots at CDCS in 1998. A chemical control trial was conducted in a greenhouse at CDCS in 1999. Soil drenches were applied using 30 mL/per plant of solutions of Benlate 50% WP, Botran 50% WP, Easout 70% WP, Ronilan 50% WP, Tilt 250 EC and water (as a check). Ronilan showed the best control of this disease followed by Botran and Rovral.

Characteristics of *Rhizoctonia solani* and their pathogenicity on *Echinacea* spp.

Isolates of *R. solani* obtained from infected *E. angustifolia* seedlings formed 12 distinctive colony types on PDA medium. Temperature had a significant effect on fungal growth, formation of sclerotia and pathogenicity on echinacea plants. Isolates also differed in virulence to 2-month-old seedlings of *E. angustifolia* under greenhouse conditions.

Fungicidal control of Sclerotinia stem and root rot on stevia

Approximately one-year-old stevia plants were inoculated with *S. sclerotiorum*. Plants were then drenched once with 125 mL/per plant of solutions of Benlate 50% WP, Botran 50% WP, Easout 70% WP, Ronilan 50% WP, Rovral 50% WP, Tilt 250 EC and water (as a check). All fungicide treatments significantly reduced the infection rate and disease severity. Botran gave the best control of this disease, followed by Ronilan and Rovral.

Varietal response of basil to *Sclerotinia sclerotiorum* under natural field conditions

Eighteen cultivars of basil were tested for adaptability at CDCS; however, prolonged periods of cold, wet weather made conditions favorable for testing resistance to *S. sclerotiorum* blight. Infection appeared in August when plants were close to flowering. Disease incidence and percent mortality were recorded in mid-September. Peruvian, Purple Delight, Sacred Green and Sacred Purple are the most resistant cultivars and showed no visual symptoms. Comoro, Spice, Thai 'Standard' and Thai 'Siam Queen' showed various degrees of branch infections, which did not cause mortality. The most susceptible cultivar was Anise, which showed a 60% DI and 56.6% mortality. Cultivar resistance will be further verified under controlled conditions.

Occurrence of ascochyta blight, powdery mildew and root rot on field pea and chickpea

Eleven pea and 18 chickpea fields were surveyed for root rot and foliar diseases (ascochyta blight and powdery mildew) in late August and early September. The fields were located in the Strathmore and Olds areas. The chickpea fields were in the Wrentham, Taber and Lomond areas. Root rot and powdery mildew was found in 8 of 10 fields surveyed. The disease severity ranged from 0.1 to 2.3 and averaged 1.7 on a 0-4 scale. The major microorganisms isolated from diseased roots were *Fusarium* spp. followed by *Gliocladium* spp., *Rhizopus* spp. and *Alternaria* spp. Other microorganisms found in minor amounts were *Aspergillus* spp., *Botrytis* spp., *Pythium* spp., *Rhizoctonia solani*, and *Sclerotinia sclerotiorum*. Parasitic nematodes were also isolated from root samples at Taber (59%) and Crossfield (22%). Ascochyta blight was found in all fields surveyed. Disease severity ranged from 4.1 to 7.0 and averaged 6.0 on a 0-9 scale, slightly lower than the mean disease level found in 1998. The range of powdery mildew

was from 0 to 5.9 (based on a 0-9 scale), with a mean of 1.1, a very low level. The majority of root rot was caused by *Fusarium* spp.

The disease ratings on chickpea were the same as for the pea. The mean ascochyta severity was 2.6, which indicates slight infection. Powdery mildew was not found in any of the fields. Only four fields were rated in the 1-2 category for root rot, which was also caused by *Fusarium* spp.

Occurrence of aster yellows on valerian in Alberta and Saskatchewan

Valerian plantings at several locations in Saskatchewan and Alberta were surveyed for aster yellows in September. Diseased plants showed symptoms including yellowing, reddening, and variegated leaves, plant stunting and phyllody. In Saskatchewan, the highest disease incidence occurred in a one-year-old crop at Prince Albert. In Alberta, disease incidence reached 97% at both Morinville and Brooks on 2-year-old crops, indicating the crop was highly susceptible and the disease was prevalent in both provinces. Multiple shoots, an abnormal vegetative feature, developed at Brooks after the aboveground portion of plants were cut.

Diseases of fruit crops

Reaction of black currant varieties to rust under natural field conditions

In cooperation with Mr. Lloyd Hausher, Fruit Crops Specialist, 28 cultivars of black currant were evaluated for resistance to rust and powdery mildew under field conditions at CDCS. These diseases occurred in mid-August. Rust spores first appeared on the lower surface of the leaves then covered the whole leaf surface and caused leaves to curl upwards. Early defoliation occurred where infection was severe. Highly susceptible cultivars to the rust were Ben Alder, Ben Lomond, Ben More, Kerry, Magnus, Topsy and Willoughby. Other cultivars showed various degrees of rust resistance and ranged from moderately susceptible to highly resistant. Infection by powdery mildew was less severe than rust infection and occurred on the top leaves and shoots. Susceptible cultivar included Ben More, Ben Nevis, Ben Sarek, Consort, Crusader, Kerry, Magnus, Tenah, Topsy and Willoughby. The other cultivars evaluated were either resistant or immune to the disease. Cultivar resistance for both diseases will be confirmed under controlled conditions.

Diseases of vegetable crops

Biological control of wire stem of cauliflower using antagonistic bacteria

Bacterial isolates were tested for their antagonistic effect on *Rhizoctonia solani*, the cause of wire stem on cauliflower and other cruciferous vegetables. Isolates 1, 2, 2a, 3 and 3a generated large inhibition zones to *R. solani* on the plates. The biomass of *R. solani* was reduced from 55% to 98% when co-cultured with these bacterial isolates. Antagonistic bacterial isolates were tested for their efficacy in controlling *R. solani* in pot studies under growth chamber conditions. Treatments included five isolates of bacteria and a control with low (1:500 mL), medium (1:100 mL) and high (1:50 mL) concentrations of *R. solani*. Although the bacteria reduced the mortality of cauliflower seedlings at the beginning in a pot study, they did not completely protect seedlings from *R. solani* infection four weeks later. More study is needed on control of wirestem in older seedlings.

Technology Transfer Services

Program staff spoke at ten growers' and professional meetings in 1999. Seven scientific papers, five abstracts and thirty two miscellaneous reports were published. Staff were involved in the activities of several professional societies and advisory committees.

Assistance was provided to Brooks Diagnostics Limited to diagnose several dozen plant disease specimens. As well, advice on disease identification and management was provided to Centre staff as requested.

R.J. Howard retained an appointment as an Adjunct Professor in the Department of Agricultural, Food and Nutritional Science at the University of Alberta, and was involved in departmental activities including lectures, diagnostic consultations and cooperative research. He was Past- President of the Canadian Phytopathological Society in 1998/99.

K.F. Chang was elected as a director of the Alberta Ginseng Association Board. Both R.J. Howard and K.F. Chang also served as committee members of the Prairie Registration Recommending Committee on Grains and the Western Committee on Plant Diseases.

Post-Harvest Technology Program

J.D. Holley

The primary objective of the post-harvest technology program at the Crop Diversification Centre South (CDCS), Brooks is to maximize the longevity and quality of stored horticultural crops. Research and technology transfer efforts are both directed towards improving storage management practices used in industry today. Each year the program screens advanced breeding lines from the Prairie Potato Breeding Program for levels of resistance to early blight, verticillium and fusarium wilt, and to a range of storage diseases and physiological disorders.

The program worked on several special short-term projects last year. Alfalfa cultivars were carefully observed to determine levels of field resistance to blossom blight infection. Carrots were treated with a new biological control agent, *Coniothyrium minitans* to evaluate its efficacy. Sugar beets were exposed to repeated freeze/thaw cycles to document loss of sucrose over time. The early blight pathogen was recovered from potato farms all across Alberta to see if a new strain was responsible for unusually severe levels of the disease.

One factor had a major impact on the post-harvest program in 1999. The computer-run post-harvest lab was upgraded to make it year-2000 compliant. Renovations were so extensive (costs exceeded $340,000), that delays in completing construction drastically reduced the amount of available space for research. Consequently a number of storage projects had to be postponed or completely cancelled part way through the season.

Research Projects

Field trials

Early blight resistance screening

Small plots of two standard cultivars and twenty-four advanced breeding lines from the Western Canadian Potato Breeding Program (WCPBP) were established in a randomized complete block design with four replicates in soil that was heavily infested with spores of the early blight fungus, *Alternaria solani*. Levels of blight were recorded for all replicates in the last week of August. One line (A81473-2) had less, and two (A082611-7 and FV11320-7) as much blight as the resistant standard, Russet Burbank. Five lines (V0319-1, V0366-1, V0468-6, V0497-1 and V0683-1) had as much, and six (DT6063-1R, CV89075, V0404-4, V0498-1, V0717-1 and V0725-1) more blight than the susceptible standard, Warba. The remaining ten had intermediate levels of early blight.

Early blight survey and aggressiveness testing

A new aggressive strain of *Alternaria solani* may be responsible for the sudden increase of early blight seen in many commercial potato fields over the past several summers. To test this hypothesis, leaves with early blight lesions were collected from eighty-six farms from across Alberta. Pure isolates of *A. solani* were recovered from every field surveyed. Pure cultures were transferred to V-8 juice agar amended with rose

bengal, exposed to high intensity light and spores used to inoculate single leaves and whole plants of greenhouse grown blight-susceptible potato (cv. Warba). Inoculation tests are incomplete so no results are available at this time.

Isolates with different levels of aggressiveness will be purified further using a standard single spore technique. Single-spore isolates will then be compared using PCR /DNA hybridization. A few isolates will be tested in replicated field trials next summer.

Verticillium wilt resistance screening

Virulent cultures of two potato wilt pathogens, *Verticillium albo-atrum* and *V. dahliae*, were grown on barley seed three weeks prior to being used to inoculate seed at planting. Two cultivars and ten advanced breeding lines were planted along with infested grain in an eight replicate randomized complete block field trial. Fifty tubers from each replicate were cut and examined for evidence of vascular browning from wilt infection after harvest. Percentages of tubers with symptoms were recorded and means calculated for each line. Three lines (V0056-1, V0266-8 and V0468-1) were more resistant and four (FV9633-6, FV9650-1, V0168-3, and V0416-7) as resistant as the standard, Russet Burbank. One line (V0379-2) was as susceptible and one (AV82101-12) more susceptible than the standard, Warba. The other five had intermediate levels of wilt resistance.

Fusarium wilt resistance screening

A virulent culture of *Fusarium oxysporum* was established and used to plant and inoculate two cultivars and ten advanced breeding lines in a second wilt screening trial using the method described in the previous paragraph. Two lines (V0266-8 and V0468-6) were as resistant as the standard, Russet Burbank. Two lines (WIS75-30 and V0379-2) were as susceptible and one (AV82101-12) more susceptible than the standard, Warba. The remaining eight had intermediate levels of resistance.

Field evaluation of cultivar resistance to alfalfa blossom blight

Seventeen alfalfa cultivars were planted in a four replicate randomized complete block trial at the Macleod farm at CDCS. Twenty mature flowers were taken from each plot replicate five times last summer and the pathogens colonizing the flowers were isolated in the laboratory. Different levels of flower infection were found on different cultivars when disease pressure was moderate for both pathogens, i.e. *Botrytis cinerea* and *Sclerotinia sclerotiorum*. When disease pressure from *B. cinerea* increased, however, flowers of all cultivars became heavily infected. Disease pressure was too low to determine the stability of cultivar resistance to infection from *S. sclerotiorum*. Prior to 1999, it was assumed that resistance would be stable for this crop. This may not be the case, at least for one of the two blossom blight pathogens. Clearly more observations are needed.

Field evaluation of Maxim a new seed piece treatment for potato

Staff from Novartis established large scale field trials, each five or more acres in size at a number of sites in six different provinces to re-test the efficacy of the new fungicide Maxim for controlling fusarium seed piece decay, helminthosporium silver scurf, rhizoctonia canker, and black scurf on potato. Staff from all provinces worked closely with the post-harvest program leader, J. Holley, to establish a consistent set of criteria for evaluating levels of each disease. Arrangements had to be made to have staff from each province do their own tuber evaluations this year, due to a lack of space in CES rooms in the post-harvest lab. Staff from Alberta, however, did store potatoes in the filacel cooler at CDCS. They observed and recorded levels of each disease in the post-harvest lab with the assistance of the post-harvest program leader. Data from the Alberta trials is now being pooled with results from other provinces. The analysis has not been completed yet, so results from this trial are unavailable at this time.

Storage trials

The consortium storage trial for processing quality and disease resistance

Breeding lines from the Western Canadian Potato Breeding Program (WCPBP) were harvested then transported to Brooks for post-harvest tests. Potatoes were loaded into CES rooms with stable storage conditions at 6°, 8° or 10°C. Samples were taken from each CES room every two months to determine effects of temperature on chip, French fry, baking and boiling colour and texture. Difficulty in achieving and maintaining required levels of humidity and temperature with the new control system (refer to introduction for details) may compromise product quality this year. Potatoes were not tested for levels of resistance to diseases, mechanical injury, and physiological stress in storage due to lack of space.

Effect of bleach dip treatments on stored carrots

A storage trial was set up to determine how bleach dip treatments affect the moisture, colour, sugar content, taste and level of disease of cellophane-bagged carrots. Caro-Choice, Eagle and Kamaran, were grown for the trial at CDCS, harvested mechanically into ½ tonne pallet boxes. Carrots were removed from the pallet boxes, washed, dipped into 0, 0.01, 0.05, 0.1, 0.25, 0.5 0.75, 1.0, 10 or 100 ppm of sodium hypochlorite, dried and packaged into two one kilogram cellophane bags. Packaged carrots were stored at 2°C and 95% relative humidity. Dipping carrots into solutions of sodium hypochlorite greater than 1 ppm adversely affected taste, sugar content, color and appearance. Levels of decay were lowest in carrots that were dipped in 0.1 to 1.0 ppm of sodium hypochlorite. Lack of consistency in the data for concentrations between 0.1 to 1.0 ppm, however, made it impossible to select an optimal treatment level. Similar inconsistencies were seen in a parallel series of experiments conducted by Dr. Jim Traquair at the Agriculture & Agri-Food Canada Research Station in London, Ontario in 1998.

Effect of a new biological control agent, *Coniothyrium minitans*, on white mold of carrot

A new storage trial was set up to see if the application of the myco-parasite, *Coniothyrium minitans*, effectively reduces levels white mold decay, caused by the pathogen *Sclerotinia sclerotiorum*, on stored carrots. Field grown carrots (cv. Eagle and Kamaran), were carefully washed, rinsed, dried, sprayed with suspensions of *C. minitans* at rates of 0, 10^5, 10^6, or 10^7 spores per millilitre, allowed to dry a second time, then packaged and stored as outlined in the previous paragraph. Levels of *S. sclerotiorum* decay were lower on carrots sprayed with suspensions of 10^7 spores per millilitre than on carrots from the check.

Effect of freezing and thawing on sucrose levels in stored sugar beets

The post-harvest program received eight ½ tonne pallet bins of freshly harvested sugar beets in October, 1998. Four bins contained healthy beets and four were filled with beets that had been badly cut and bruised at harvest. Eight pallet bins were organized into pairs. Each pair of pallet bins had healthy and damaged beets. The first pair was loaded into a stable controlled environment storage (CES) room at 4°C and 95% relative humidity, the second into a freezer set at -20°C, the third into a CES room programmed to simulate outside temperature fluctuations for a warm winter and the fourth into a CES room programmed for moderate winter conditions. Four sugar beets were removed at random from each pallet bin as they were being loaded in storage. The water and sugar content were determined for each beet. Water and sucrose levels were recorded for beets in each bin as described above every four to six weeks from the beginning of November to the end of April. Extensive mold developed on sugar beets in the control (on unfrozen beets stored at 4°C and 95% relative humidity) four weeks after they were first loaded into storage. Beets exposed to repeated freeze/thaw cycles were also affected but the mold grew on them much more slowly than on the control. Colonization by micro-organisms confounded the data so profoundly that it was impossible to compare sugar

losses in treated and control bins. Clearly the entire experiment had to be repeated using hand-harvested rather than mechanically-harvested beets to obtain a useful and reliable set of data. Space in the post-harvest lab was so limited this winter that repeating storage experiments from last year along with this season's treatments was completely impractical. Therefore the entire three-year research project was terminated.

Technology Transfer Services

Routine telephone queries about potato and vegetable diseases and about storing potatoes, carrots and other garden vegetables were dealt with as they arose. The program leader, J. Holley, presented data from an extensive trans-Canada storage trial designed to document the efficacy of Maxim (a new fungicide seed piece treatment for potato) to colleagues from all across Canada and the United States and to key representatives from the potato industry at a special symposium held last March in Toronto. The leader also published two articles in Agri-News. A chapter illustrating and describing alfalfa diseases was prepared for a new production guide. The leader also presented a seminar on how fungicide resistance develops at the fall meeting of the Irrigated Alfalfa Seed Growers Association (IASGA).

Last summer potato growers from all across Alberta were contacted directly to obtain permission to take samples of early blight infected leaves for the early blight survey described earlier. A number of problems and questions were dealt with over the telephone as the survey was being organized. Extra visits to problem fields were scheduled as required to address the concerns of individual growers. This was particularly important in southern Alberta where many of potato growers are new and relatively inexperienced. The program leader also had a great deal of direct contact with alfalfa seed growers this fall. Many growers were concerned because they felt that the fungicide Benlate (benomyl) was ineffective in controlling blossom blight. Growers made arrangements with the program leader to have their fields tested for fungicide resistance next summer.

Last fall the post-harvest program leader agreed to act as chairman for the potato chapter for the Western Committee on Plant Diseases (WCPD). He continues to participate on the Alberta Potato Research Committee (APRC) and on the Storage Committee of the Prairie Potato Council (PPC).

Soil and Water Agronomy Program

R.C. McKenzie, S.A. Woods and L. Hingley

The soil and water agronomy program conducts research on water, fertilizer and sustainable soil quality requirements of special and horticultural crops as well as irrigated forages. Some research projects were done cooperatively with staff from other programs at Crop Diversification Centre South (CDCS) and other divisions of Alberta Agriculture, Food and Rural Development (AAFRD). Soil samples were analyzed by AAFRD's Soil and Crop Diagnostic Centre, Edmonton. Research funding was provided by: Alberta Agricultural Research Institute's (AARI) Farming for the Future Matching Grants Research Program; the Potato Growers of Alberta; The Potash and Phosphate Institute of Canada; Westco, Southern Agri Services; Canadian Snack Foods Association and Pan Canadian Petroleum. Farmers who cooperated with field research projects were E. and J. Stolk of Taber, J. Rozendaal of Hays and C. Bydevaate from Taber. Research on multispectral imagery of potatoes was done in collaboration with Itres, a company which does aerial remote sensing for forestry and other applications.

Precision farming

Salinity tolerance of potatoes

The purpose of this project is to measure the yield reduction of potatoes on saline soils. With newly available commercial services for mapping, farmers will be able to map their fields and decide what areas are suitable for growing salt sensitive crops such as potatoes.

In April, 1999, a 310 ha field of potatoes which contained some saline areas, was mapped for salinity using an EM38 salinity meter and Global Positioning System (GPS) technology. The field was mapped again in October, 1999, after harvest of potatoes. Itres flew the field and collected multispectral imagery. Sixty-four samples of tubers were collected and salinity was measured at each sample site. This information was used to develop a relationship between salinity and tuber yield. Remote sensing imagery of the crop will be compared to salinity maps of the field.

Site-specific management of potatoes

Site specific management involves applying adjusted amounts of inputs such as water, fertilizers, and herbicides as required to different portions of a field. This is now feasible using GPS controlling equipment such as fertilizer applicators or herbicide sprayers. At a less technical level it can be done by subdividing the field into different units and applying different inputs to each subdivided unit.

This project commenced in 1996 and will conclude in 1999/2000. The objectives are:

- to measure and map yield variability within a field.
- to determine the effects of soil type, landscape position, soil fertility, diseases and weeds on potato yield.
- to determine the variability in yield of preceding crops, and to relate this to field variability and tuber production.
- to measure the cost benefits and environmental influences of site-specific management.
- to evaluate the use of remote sensing and digital image analysis of fields to detect nutrient deficiencies and diseases of potatoes.

Two, 27 ha potato fields were monitored in detail. One was irrigated with a centre pivot and the other with a corner pivot. Soil texture was determined at 50 sample points, and at these points rainfall, irrigation, and soil moisture records were taken. Plant petiole samples were taken three times during the growing season for nutrient analysis. Yield data and remote sensing imagery were also collected and compared to soil and crop characteristics to explain what caused variations in yield.

The data showed that soil texture, tissue nutrient content and the available soil moisture status of potato fields were quite variable. Tissue phosphorus and nitrogen, declined rapidly during the growing season in portions of the potato fields. The potatoes were deficient in tissue potassium in early July, in the first three years but not in the fourth year on both fields, but there was adequate potassium on both fields at the end of July and in August. Low soil temperature is known to reduce the uptake of potassium, however, June and early July, 1999, was below normal temperatures and 1998 was above normal.

In 1996, soil moisture was lower under the outer portions of the center pivot and on the corners of the corner pivot system. In 1997, the centre pivot system was converted to a low pressure system and, as a result, water application was higher on the outer part of the system and lower near the centre. Tuber size and specific gravity was related to water application with fewer and larger tubers in the areas which received insufficient water as compared to areas with adequate water. This was the most important factor controlling yield and quality of tubers.

Yield was determined on strips which received various rates of nitrogen and phosphorus fertilizer and were compared to yields obtained from the farmer's fertilizer

rates. In the fall of 1998, two rates of each of compost, manure and phosphorus were applied to one field. Manure and compost as compared to phosphorus fertilizer were found to significantly reduce the number of diseased plants and had no effect on the amount of rhizoctonia and scab on tubers. This is a positive result towards use of manure and compost as it indicates they do not increase diseases in potatoes and in some cases may reduce the occurrence of disease.

Soil fertility

Phosphorus requirement of potatoes

Southern Alberta has an expanding irrigated potato industry which is expected to reach about 18,200 ha (45,000 acres) by 2001. This will require rotations involving about 73,000 ha (180,000 acres).

The ability of potatoes to absorb phosphorus (P) is lower than many other crops which means they require more phosphorus fertilizer than most other crops. The P recommendations for potatoes in Alberta have been based on maximum applications of 40 kg/ha (80 lbs/ac of P_2O_5). New recommendations developed in north western USA suggest maximum rates of 200 kg/ha P (P_2O_5 at 400 lbs/ac) on low lime soils and 256 kg/ha P (525 lbs/ac P_2O_5) on high lime soils. Alberta farmers are uncertain what rates to use.

Manure and compost are high in P content. Disposal of manure and manure compost often take place near the sources of the manure. This creates situations where the soils accumulate excess P and contribute P to surface waters. Most of Alberta's lakes and rivers within agricultural areas already contain excess levels of P and nitrogen. Alberta potato farmers are reluctant to use manure as a fertilizer because it may cause scab on potatoes and contribute weed seeds. They are unfamiliar with compost which has only become available in larger quantities since 1999. If manure and compost are proven to be a satisfactory source of P for potatoes, this will also aid in alleviating an environmental problem.

In 1999 two P experiments were set out. The first, a small plot experiment, had 9 rates of P from 0 to 900 kg/ha. The second, a field scale experiment, had 6 rates of P from 22 kg/ha to 380 kg/ha and 4 rates of compost from 9 tonnes/ha to 42 tonnes/ha.

Tissue nutrient levels, yields, tuber size, specific gravity and hollow heart were determined on both experiments. Increasing rates of phosphorus had no significant effect on yield. In the first experiment tuber size was slightly reduced on treatments receiving high rates of P.

Applications of drilling muds to agricultural lands

Several types of drilling mud at 3 rates were applied to irrigated and dryland crops and to grassland to determine the effect of the muds on crop growth and soil quality.

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates

The soil and water agronomy program co-operated with the nursery crops program with this project. Field-grown plant material provides about $11.2 million in sales to Alberta growers.

Colorado blue spruce and green ash were planted in 1997 at Brooks and Edmonton and four rates of soil nitrogen were applied at each site. No significant differences in growth were observed in 1997, 1998 and 1999. For further details of this project, see the report in the nursery crops program section of this annual report.

Technology Transfer Services

Soil and water information was provided to a diverse audience through scientific papers, technical reports and research publications. Presentations were made at technical conferences and producer meetings and inquiries were answered through telephone contacts, office visits and correspondence. Frequent inquiries were received about the suitability of water quality for use in irrigation.

The yield monitoring projects attracted attention from the media and various agricultural industries. Presentations on this project were made at a number of meetings, and in agricultural publications. Information on crop tolerances to soil salinity and methods of measurement of soil salinity was provided to farmers, extension personnel and researchers.

Special Crops Program (Brooks)

M. Bandara, C. Wildschut, E. Russell and L. Ost

The special crops program at the Crop Development Centre South (CDCS) at Brooks is primarily responsible for the evaluation, introduction, and development of alternative and new crops for southern Alberta through applied and adaptive research programs. Some study projects are conducted in collaboration with other research programs at CDCS, other divisions of Alberta Agriculture, Food and Rural Development (AAFRD), University of Alberta, University of Saskatchewan and local industry partners. Different funding sources such as Farming for the Future Matching Grants and Direct Funding Grants, Regional and Cooperative Variety Testing Programs and also several processing industry partners provide the financial support for the programs.

Agronomic and physiological studies are conducted on pulses, herbs and spices, medicinal and essential oil crops. Considerable time is invested on new crop cultivar/line and new species evaluation studies. A small component of the program is the testing of new cultivars and breeding lines of cereals and oilseeds under irrigation.

Detailed project results are presented in CDCS Pamphlet 99-20, *Special Crops Cultivar Trials*.

Research Projects

Regional/Co-op trials

Newly developed breeding lines and promising cultivars of lentils, chickpeas, drybeans, fieldpeas, fenugreek, and mustard received from various crop breeding programs are evaluated under dry land and irrigated conditions in southern Alberta, to select suitable cultivars/lines for the region.

Drybean cultivar evaluation and cultural practices

Ten yield tests, with various dry bean lines and varieties, were conducted at Brooks and Bow Island under irrigated conditions to collect required information for screening, registration and recommendation purposes. An unusual cool and wet summer delayed growth and development of bean plants, but a longer growing season enabled most to reach maturity with a slight decrease in seed quality, especially in the fringe dry bean growing conditions around Brooks.

The emphasis in the dry bean cultivar testing in southern Alberta is on yield performance, early maturity and architecture of a dry bean plant that allows for narrow row configurations, direct combining and consequently an expansion of the present dry bean production area. Development of new lines of dry bean with desired characteristics is being conducted through breeding programs at the Lethbridge Research Center, Agriculture and Agri-food Canada and the Crop Development Centre at the University of Saskatchewan. In 1999, six new lines of dry beans (one pink, one great northern, three pinto and one small red) were recommended for variety registration by the Prairie Registration Recommending Committee on Grains (PRRCG).

Six irrigated locations in southern Alberta were established to test these newly registered cultivars under the auspices of the Regional Pulse Varietal Testing Program.

Other pulse crop cultivar evaluations and cultural practices

Eleven fieldpea cultivar trials were conducted at Brooks, Bow Island and Standard to evaluate lines and varieties for screening and regional adaptation purposes. Seven yellow and five green type fieldpea lines were recommended for variety registration by the PRRCG. Most lines were higher yielding than Carneval, generally earlier maturing and had acceptable disease resistance and quality characteristics. In 1999, 23 sites in different geographic regions and soil zones of Alberta and the Peace region of British Columbia were established to test new registered fieldpea varieties.

Different lines and registered varieties of other pulse crops, such as lentils, chickpeas and soybeans, were again evaluated for registration and regional adaptation. Eight chickpea regional tests (four Kabuli and four Desi types) were established under dry land conditions at Bow Island, Brooks, Standard and Carmangay. Brooks and Bow Island were the only sites harvested. The other test sites suffered from a cool and wet summer and were not harvested.

Other special crop cultivar evaluations and cultural practices

Several cultivars and lines of canary seed, mustard, natto soybeans, fenugreek and hybrids of sunflowers, silage and grain corn were evaluated for potential registration and regional adaptation. The sunflower and grain corn test plots at Bow Island suffered from bird damages.

Cereal yield and variety trials

Three barley and four wheat trials were conducted under irrigation at Brooks in conjunction with the Field Crop Development Center in Lacombe. The barleys included 2 row (15 lines), 6 row (14 lines) and hulless (12 lines); the wheats included soft white spring (5 lines), hard red spring (22 lines), durum (11 lines), and a utility (15 lines) combined with triticale (7 lines). Data was collected throughout the season for growth habits, pest and disease incidences, maturity and seed yield. Samples of the hard red spring wheat were forwarded to Agricore for protein analysis.

Oilseed yield and variety testing

One flax trial (12 lines) and two canola trials; one rapa (8 lines) and one napus (49 lines) were conducted and the data collections were similar to cereal trials. An unusual cool and wet summer delayed maturity and harvest in both cereal and oilseed studies.

Fall seeding studies

Fall seeding or dormant seeding refers to the planting the seeds of a crop species in the fall, before freeze-up. With fall seeding the seed remains dormant in the soil over the fall and winter months, and germinates in the spring when the conditions are favorable. Fall seeding of small seeded spring crops such canola is becoming popular among the growers on the prairies because of several advantage such as improvement in both seed quality and yield, over those of spring-seeded crops. Using the canola crop model, fall seeding studies were established with using coriander, dill, anise, ajowan (*Carum copticum*), mustard and calendula (*Calendula officinalis* L.). Seeding rate and seed coating were used as treatments. The crop performance will be evaluated and compared with that of spring-seeded crops in the 2000 cropping season.

Ten lentil cultivars received from the Crop Development Centre at the University of Saskatchewan, were seeded into research plots at the CDCS in the fall. One half of seed of each cultivar was coated with plastic polymer and the other half was uncoated (untreated control). Treatment effect on winter survival and crop growth will be assessed in the 2000 cropping season. Crop phenology and seed quality will be compared with those of spring-seeded crop.

Seed priming studies

Anise (*Pimpinella anisum* L.), a member of the *Apiaceae* family is characterized by slow and erratic germination and poor seedling emergence. Previous studies have shown that seed priming can enhance and synchronize seed germination in several slow germinating species. A study was conducted using two unnamed anise cultivars, to evaluate the effect of seed priming with water or ethyl alcohol on seedling establishment, crop growth, maturity and seed yield. Results indicated that priming of anise seed with water, 0.5% or 0.75% ethyl alcohol prior to seeding significantly increased the stand establishment, but had no effect on final plant height. Depending upon the cultivar, plants raised from primed seeds, flowered 3-5 days earlier than the untreated controls. Irrespective of priming solution, plants from all the priming treatments matured at least 4 days earlier than the untreated controls. Despite these phenological differences, seed priming had no significant impact on seed yield. However, early and uniform crop maturity would be the main beneficial effects of the priming treatment.

Evaluation of calendula as an industrial crop for the Prairies

Calendula is a flowering annual which is grown as an ornamental and medicinal plant throughout the prairies. It is a member of the *Asteraceae* family and has an indeterminate flowering habit. The flowers of calendula have been used as a source of medicinal ingredients for over 100 years. Calendula also accumulates a fatty acid in its seed oil, which is known as calendic acid. This fatty acid is the most rapidly oxidized fatty acid known in nature and as such has an extensive number of applications in the plastics, paints and coating industries. Several studies were established to evaluate the effect of genotype, location, seeding rate, seeding date, late flower harvest on seed yield, seed oil content and seed oil composition under field conditions in southern Alberta. The cultivar Resina (yellow flowered cultivar) matured at least 10 days earlier than Erfurther Orangefarbigen (orange flowered cultivar). Increasing seeding rate from 6 kg/ha to 12 kg/ha had no impact on the seed yield, although those plants grown at higher seeding rates, were taller than those at lower seeding rate. Earlier seeded crop (May 18) had a significantly higher stand establishment than that of late seeded crop (May 30) of both cultivars. Despite that, seeding date had no effect on seed yield. Harvest of late producing flowers (after mid August) had no impact on seed yield. However, delaying the date of harvest of late producing flowers consistently reduced the flower yield. Essential oil extraction from both seeds and flowers and analysis for oil composition are in progress.

Adaptability, cultivar development and agronomic studies of essential oil, spice and health promoting crops

The purpose of this project was to evaluate different lines/selections of essential oil, spice and health promoting crops for adaptability under the growing conditions in southern Alberta and to develop management practices for these crops. Selected plant species were grown in test plots at the CDCS and further evaluations are in progress.

In 1996 and 1997, studies were established to evaluate the effect of plant spacing on root and seed yields of *Echinacea angustifolia* and *E. purpurea*. Among the spacing combinations (30 or 60-cm between rows and 15 or 30-cm within row) used in these studies, 30 cm x 15-cm was the most desired plant spacing for both root and seed production in echinacea. However, wider row spacing may require, when using inter-cultivators for weed control.

A study was established in 1997 to evaluate the effect of method of seedling establishment on plant growth and seed yield of *E. angustifolia*. Treatments included direct seeded crops, using unstratified (untreated control) seed, bleach & ethrel-treated seed and stratified seed under low temperature conditions (standard treatment) and transplanted crop. Standard stratified treatment produced the highest and the untreated control produced lowest plant stand among the treatments. Plants from the transplanted and standard stratified treatments were significantly taller and produced significantly

higher seed yield (over 2-fold) than that of unstratified and bleach and ethrel treatments. However, treatment had no effect on mean seed weight.

Effect of single application of plant nutrients on plant growth and root yield of ginseng (*Panax quinquefolius* L.) was studied under field conditions at CDCS from 1996 to 1998. Results indicated that Mg and micro-nutrients (Zn, Mn, B and Fe) had no significant effect on tissue nutrient contents or root yield. Micro nutrients applied alone or combined with N:P:K had no impact on seedling emergence, plant height or root yield. However, application of N:P:K plus Zn or N:P:K plus other micro-nutrients increased Zn and B concentrations in tissues.

A study was established in 1996 to evaluate the impact of mulch management on winter survival, plant growth and root yield of ginseng at CDCS. Use of a thermal blanket on the straw mulch (10-cm in depth) resulted in an early emergence of ginseng shoots in the spring, but the seedlings were injured by the late spring frost resulting in a lower plant population. Consequently, the root yield of the thermal blanket treatment was significantly lower than that of straw mulch treatment. In a separate study, result indicated that increasing the mulch depth from 5 to 15-cm consistently reduced the percentage of seedling emergence. Timing of mulch removal (mid April, early May or mid May) had no significant impact on the ultimate number of seedlings that emerged. A separate study was established to evaluate the interaction effect of mulch depth (5, 10 and 15-cm) x mulch removal (mulch removed vs. not removed) on plant growth and root yield was evaluated. Leaving the mulch at 15-cm in depth resulted in a reduced plant population and consequently lowered root yield.

Crop selections and improvements

Different mint clones selected from previous evaluations are being further evaluated for desirable traits such as higher oil content and oil quality and crop growth. Crop selection program is in progress using different genotypes of coriander, fenugreek and borage for higher oil content and quality, and seed yield.

Technology Transfer Services

Program staff continued to answer numerous inquiries on the production of special crops, particularly on herb, spice and essential oil crops. Information was contributed on special crops to producer newsletters and the news media, and the special crop varietal performance factsheet was updated. The program staff participated in courses, seminars and field tours. Demonstration plots of various special crops, including herbs, spices, essential oil, medicinal plants and other new crops, at Brooks, Bow Island and Standard were visited by a large number of interested individuals and groups. Extension staff and other interested parties were provided with planting materials for demonstration and field testing continued to help herb, essential oil and spice producers evaluate new crops and to develop their agronomic practices. The Alberta Regional Special Crops Varietal Test was coordinated, prepared and distributed. The performance data of registered varieties of fieldpeas, dry beans, lentils, faba beans and mustard was prepared and distributed to cooperators, specialists, growers and agribusinesses.

The program staff has been working with AVEC, the University of Alberta and the University of Saskatchewan and supplied various planting materials for processing and analytical studies. Also assisting various essential oil evaluation projects by providing information and lending laboratory equipment.

Special Crops Program (Edmonton)

S.F. Blade and N. Clark

Alberta producers are interested in diversifying their production. This was especially true in 1999 as prices tumbled for several conventional crops. One successful strategy is to incorporate new crops into the farming system. The special crops program is dedicated to introducing new crops which will contribute to the long-term viability of agriculture in the province. Diversification can contribute to improving crop rotations through inclusion of pulse crops, reduce producers to price volatility in traditional crops and expand the opportunities for value-added processing in Alberta. The program serves both large-scale conventional farmers and less-experienced entrepreneurs who wish to get involved in some of the more intensive production and processing opportunities presented by specific new crops.

1999 was a very productive year for the special crops program at the Crop Diversification Centre North (CDCN), Edmonton. A state-of-the-art Wintersteiger combine for harvesting research plots was purchased, and a Fabro no-till precision drill was ordered. Both these machines expand the program's capability to do agronomic research. Mr. Ken Lopetinsky, M.Sc., will take over the duties of provincial pulse agronomist and work as a colleague with the CDCN special crops program. In addition, a new crops agronomist is to be hired who will work at the Beaverlodge Research Farm as part of the New Crop Development Unit. This position will provide the "third front" of new crops work, in collaboration with Crop Diversification Centre South (CDCS), Brooks and CDCN.

The special crops program at CDCN has been active in the identification and development of economically-promising crops since 1995. The focus has been on several categories of new crops: pulses, spices, alternate crops, herbs (medicinal, culinary and aromatic) and fibre crops. In 1999, the program entered its first three breeding lines into the Western Field Pea Cooperative Trial. The lines performed very well; it is anticipated that after the second (and final) year of mandated testing that at least two of the lines will be registered released for western Canadian growers. The program also participated in several advanced yield trials on additional field pea lines currently in development, along with several agronomic trials on both field pea and other pulse crops. This was the final year of the field pea/barley silage trial which has been done in collaboration with Zone #3 of the Alberta Pulse Growers Commission and Ken Lopetinsky.

The program is represented on the Provincial Pulse and Special Crops team, Alberta Agriculture, Food and Rural Development (AAFRD) Special Crops Product Team, the Information Technology Committee and the Applied Research Strategy Group. The program was actively involved in the preliminary development and establishment of the Alberta New Crops Network which is a new industry group focused on production and marketing issues of a wide range of new crops.

The Special Crops Program would like to acknowledge the contribution of Bongbemi Nfor, Martin Blank, Teresa Hegg, Astatke Belay, Sandy Smith, Cynthia Fedun, Leah Maskewich, Katherine Andrew and Nadia Geschke for their assistance in 1999.

Research Projects

Field pea breeding and germplasm evaluation

CDC Advance — To jumpstart the field pea breeding program the program was able to collaborate with the Crop Development Centre (CDC) in Saskatoon to obtain early-generation lines from crosses which were targeted to the cool, moist conditions of Alberta. Following original unreplicated screening in 1996, a replicated preliminary yield trial was conducted in Edmonton and Grande Prairie in 1997. The elite material was put into a multilocation yield test in several sites in both Saskatchewan and Alberta. The 1998 results identified three yellow cotyledon pea and one green cotyledon pea that

out yield the checks and which will be included in the 1999 Western Field Pea Cooperative conducted by the Prairie Registration Recommending Committee for Grain. These three pea lines performed in the top 15% of the Co-op Trials. It is intended to seek registration for them following the second mandated year of testing in 2000. Of particular interest is a formal agreement will be signed between the Alberta Pulse Growers Commission and the Saskatchewan Pulse Crop Development Board which will merge the CDCN and University of Saskatchewan pulse breeding programs to ensure that new, superior genetic material will be available to farmers in each province. The commodity commissions have guaranteed long-term, stable funding for the CDCN breeding program.

AAFRD/AAFC Breeding Agreement — In 1997 an agreement was signed between CDCN and the Agriculture and Agri-Food Canada Field Pea Breeding Program based in Morden, Manitoba. Approximately 1200 lines were tested in 1997, and the best 112 were tested in a preliminary yield trial at CDCN in 1998. The 42 elite lines were evaluated by multilocation testing in 1999, and will be placed into Cooperative Trial testing in 2000.

CDCN — Crossing blocks were set up at CDCN, and F_1 and F_2 generations were advanced in 1998. This new material will be evaluated with several objectives in mind: plant maturity, height, harvestability, plant architecture, disease resistance, seed vigor and yield. Several hundred plants were selected in 1999, and these will be early-generation yield-tested in 2000.

Intensive pea management

In collaboration with other sites in Alberta (Grande Prairie—Paul LaFlamme; St. Paul—Kirsty Piquette; Vermilion—Terry Buss and Camrose—Battle River Research Group) an agronomic trial was set up to evaluate the impact of four major management issues in the production of field pea. The four variables were seeding date, seeding rate, herbicide water volume and fungicide application. There was wide variation in how yield was affected by these factors; this work was repeated in 1999. Preliminary results from 1998-1999 indicated that improper management resulted in severe reductions in yield which may explain why Alberta producers experience low yield stability for their field pea production.

Table 5. Summary of main effects for 1998/99 intensive pea management data.

Production Practice Category	Specific Main Effect	# of Yield Increases	Site-Years Tested	Frequency of Yield Increases	Range of Actual Yield Increase
Plant stand density	7 > 4 plants/sq ft	6	12	50%	10 to 74%
	4 < 7 plants/sq ft	1	12	8%	34%
	7 = 4 plants/sq ft	5	12	42%	N/A
Herbicide timing	2 node vs 8 node	6	9	67%	22 to 125%
	8 node vs 2 node	0	9	0%	N/A
	2 node = 8 node	3	9	33%	N/A
Seeding date	early vs late	3	7	43%	34 to 83%
	late vs early	2	7	29%	15 to 27%
	early = late	2	7	29%	N/A
Fungicide application	Applied > Not Applied	0	8	0%	N/A
	Not Applied > Applied	0	8	0%	N/A
	Applied = Not Applied	8	8	100%	N/A

Field pea inoculant trials

The last year of this experiment in collaboration with Dr. George Clayton (AAFC Lacombe) was conducted in 1999. The basis of the experiment was to determine the effects of inoculant formulations (liquid, peat powder, granular) with starter nitrogen (0, 20, 40 or 80 kg/ha of actual N) on nodulation, flat pod N content, final N content in grain and biomass and field pea grain yield adjacent to the 1997 sites at Vegreville and Calahoo. The previous years site was seeded to barley at each of the two sites. The barley was harvested at each of the two sites to investigate the effect of the previous years field pea inoculant/fertilizer treatments. In 1999 field pea crops were re-seeded on barley stubble to quantify the effects of inoculant formulations used in the preceeding field pea crop, to identify if granular inoculants provided enough rhizobia to increase *in situ* field rhizobia numbers.

Field pea-barley silage trial

In 1999, in cooperation with Ken Lopetinsky and Zone #3 of the Alberta Pulse Growers, a field pea-barley silage trial was grown at CDCN and Barrhead. Fourteen field pea lines were grown in sole crop treatments, and intercropped with Seebe barley (1 bu/acre). Seven grain pea (Carrera, Integra, Carneval, Espace, Grande, Pekisko, Swing, Eiffel) and seven silage pea (Arvica, FP93074, MP1106, Packer, Performance 4010 Trapper and PC-12-89-335) lines were tested at either 0 or 60 kg/ha added nitrogen. Increased biomass and protein harvest were observed, and there were significant differences in biomass and protein and grain yield for fertility treatment, cultivar and location.

Table 6. Biomass yield (t ha^{-1}) for eleven field pea cultivars grown at two locations (1998-1999 combined data).

	Edmonton				Barrhead			
	0 kg N ha^{-1}		60 kg N ha^{-1}		0 kg N ha^{-1}		60 kg N ha^{-1}	
Pea type	Inter crop	Sole	Inter crop	Sole	Inter crop	Sole	Inter crop	Sole
GRAIN								
Carneval	8.2	7.95	8.73	8.97	11	10.3	10.2	10.5
Carrera	8.46	7.14	9.36	9.28	10.2	6.95	9.76	9.35
Eiffel	8.49	6.51	8.43	7.71	10	8.47	10.3	9.57
Grande	9.95	9.08	9.52	7.87	9.91	11.8	12.2	9.3
Integra	8.49	6.27	7.99	7.5	8.61	8.14	8.68	7.59
Swing	7.14	7.21	9.3	7.3	10.2	7.95	10.2	9.96
Average	**8.49**	**8.83**	**8.9**	**8.1**	**9.98**	**8.92**	**10.2**	**9.37**
SILAGE								
FP93074	9.31	10.3	9.77	9.16	9.72	9.42	10.6	9.42
Packer	9.28	7.87	10.5	9.15	10.7	11.1	10.7	10.7
Perform 4010	9.4	9.91	11.4	10.2	9.09	11.7	10.1	11
CDC/Sask	8.47	8.41	9.36	8.65	11	10.6	9.67	10.6
Trapper	8.39	7.91	9.28	8.43	10	8.71	10.6	9.21
Average	**8.97**	**8.89**	**10.1**	**9.11**	**10.1**	**10.3**	**10.3**	**10.2**

Barley (high)	**4.75**	**6.17**	**9.95**	**10.48**
Barley (low)	**4.41**	**5.52**	**8.58**	**9.85**

LSD ($p < 0.05$) for differences between any pea cultivar and barley = 0.86 t ha

Pulse crop screening (lentil, faba bean, chickpea)

In collaboration with several seed companies and breeding programs lentil lines were tested in Vermilion (in cooperation with Terry Buss), chickpea lines and faba bean at CDC North. In collaboration with Randy Bjorklund the silage potential of ten faba bean lines was assessed by collecting data on biomass production and feed analysis. In collaboration with CDCS personnel four excellent fenugreek lines were identified which have good nutritional composition and maintain forage quality until late in the season.

Special crops adaptation trials

In collaboration with Ken Lopetinsky several new crops were tested in Namao and Barrhead to assess the potential of these new crops for the north-central region of Alberta. Data were collected on plant maturity, disease incidence, plant development and economic yield. An additional trial was planted at the AAFC station in Beaverlodge, with the assistance of Paul LaFlamme. An additional screening/demonstration trial was planted at CDCN.

Borage agronomy

Borage (*Borago officinalis*) is a new crop which has been grown on more acres in the past few years because it can be very productive in the Alberta environment. A second-year trial tested the effects of early and late-planting and fertility rate on seed production. Data on mid-season and maturity biomass was collected, as well as early, mid and late-season harvesting. Due to the indeterminate nature of seed set, there is a great deal of interest in what seed harvest date will produce the highest yield.

Spice agronomy

The 1999 trials were the fourth year of a spice agronomy trial that incorporated the use of nurse crops for the production of biennial caraway. The use of coriander, field pea and Polish canola in the first year was evaluated on second and third year caraway seed yield.

Herb screening (medicinal, culinary, aromatic)

Approximately 200 species were started in the greenhouse and direct-seeded to conduct a preliminary screening process for a wide array of herbs that could have commercial potential in Alberta. The performance of several of the fourteen basil lines were impressive, and large samples were provided to the Agricultural Value-Added Engineering Centre for work on essential oil distillation. In addition, larger, replicated agronomic trials of ginseng (fifth year harvest) and echinacea (comparing densities and ridge vs flat cultivation) were done. The perennial herbs were maintained to identify species that can overwinter.

Low-THC hemp research

In 1999 was the last year of the low-THC hemp research at three locations (grey-wooded, black and dark brown soil zones) in collaboration with Curtis Weeks and Paul LaFlamme. Cultivars from the Ukraine, Germany, France, Romania, Ukraine, Poland, Hungary and Finland were tested. A date of planting trial at CDCN was done, and a continuation of the work on evaluating this crop as a silage opportunity. Data showed high protein (>20%) and good biomass accumulation, particularly at the first cutting during July.

Technology Transfer Services

Due to the high interest, program staff were called upon to answer numerous enquiries regarding a wide range of new crop opportunities relating to pulses, spices, medicinal plants and fibre crops. Staff contributed articles on crop diversification and species-specific topics to producer newsletters, industry periodicals and provincial newspapers. The interest in crop diversification resulted in several media interviews with newspaper, radio and television which were the source for further enquiries from

the general public. Due to the great need for increased knowledge about these new crops, staff contributed to a large number of courses, seminars and field tours.

The Special Crops Field Day held at CDCN was a tremendous success; all Centre tours during the year hosted more than 500 participants. Staff assisted members of the Pulse and Special Crops Team by assisting with securing planting materials for demonstrations across the province, and sourcing technical information which was then extended to clients. A new innovation was involvement in Ask The Expert and Agri-Ville electronic forums provided an opportunity for staff to interact directly with producers in a new and highly effective forum. Clients included producers, other AAFRD Units, universities, Agriculture and Agri-Food Canada, other provincial agriculture departments, applied research associations and agri-industry. An interesting component of the work is that many of the trials were done as researcher-managed on-farm experiments, which allowed neighbors to view technological innovations in their own area. Program staff served as college and university guest lecturers, independent study course mentors (U of A) and resource people for a number of industry organizations.

Weed Science Program

R.Esau and B. Kruger

The major emphasis of this program is to develop new weed control systems and improve existing ones for vegetable, potato, fruit, nursery, pulse and special crops. Commercial and experimental herbicides, as well as different crop management techniques, are evaluated to accomplish this objective. A second objective is to determine safe recropping intervals for potato and special crops following the use of soil-persistent herbicides. Weed control information is provided to commercial growers by phone, farm visits and workshops.

Research Projects

Weed control in vegetable crops

Onion — This crop is a weak competitor against weeds and requires a preemergent or early postemergent herbicide with good residual activity. Pendimethalin (Prowl) meets this requirement partially in that it has residual activity. A trial was conducted to broaden the weed control spectrum for pendimethalin by testing tankmixes which include oxyfluorfen (Goal) and bromoxynil (Pardner). Glyphosate (Roundup) was applied initially to burn off weeds prior to crop emergence. The herbicide treatments were applied at the one-leaf stage of onion; some treatments were followed by linuron (Lorox) or a tankmix of oxyfluorfen and bromoxynil at a later stage. Norstar onion yields were significantly reduced by the herbicide treatments in comparison to the hand-weeded check. It appears a herbicide program for onion will have to be supplemented with cultivation.

Squash — As in 1998, a micro-encapsulated formulation of clomazone (Merit) was tested in acorn squash. In addition, the registered herbicide napropamide at 1.1 and 2.2 kg ai/ha, applied preemergence, was also included in this trial for comparison. Leaves of acorn squash were slightly whitened by clomazone treatments, but these symptoms soon disappeared. In a crop tolerance trial (all weeds were manually removed), acorn squash total crop yields were unaffected by clomazone and napropamide but significantly reduced by bentazon (Basagran). In another trial, weeds were manually removed only from the hand-weeded check. Yields were significantly lower for clomazone (0.28, 0.56 and 0.84 kg ai/ha), napropamide and bentazon in relation to the hand-weeded check. Clomazone treatments did not adequately control redroot pigweed and napropamide failed to control hairy nightshade, redroot pigweed, and mustard.

Carrot — A weed control study was initiated to determine crop tolerance of carrots to a mixture of linuron (Lorox DF) and sethoxydim (Poast) + Merge. Control of volunteer cereals by this mixture was also evaluated. No crop injury was noted for any of the treatments, however, yields were significantly reduced in comparison to the hand-weeded check. This yield reduction was attributed to weed competition from mustard and lamb's-quarters. Control of volunteer barley appeared to be reduced in the treatments where linuron and sethoxydim + Merge were tankmixed in comparison to sethoxydim + Merge applied alone.

Weed control in potato

Work with potatoes focused mainly on using rimsulfuron (Prism) in tankmixes to broaden the spectrum of weeds controlled. Rimsulfuron + metribuzin (Sencor/Lexone) treatments had lower marketable yield (Shepody and Russet Burbank) than the hand-weeded check, however, yields for linuron (Lorox/Afolan) + rimsulfuron and linuron + pendimethalin (Prowl) treatments were not reduced. Rimsulfuron + metribuzin suppressed hairy nightshade, but there appeared to be sufficient competition from remaining weeds to reduce crop yields. The outstanding treatments were a combination of linuron + pendimethalin applied pre-emergence (ground crack) and linuron applied pre-emergence followed by rimsulfuron + Agsurf post emergence.

A second potato trial was initiated to determine the response of potato to simulated carryover of sulfosulfuron and crop tolerance to a post emergence application. First year results showed minor crop injury (<3%), total and marketable yields were unaffected. Sulfosulfuron provided good control of mustard, redroot pigweed and barnyard grass but did not adequately control hairy nightshade and lamb's- quarters.

Herbicide carryover

A 1:1 mixture of imazamox + imazethapyr (Odyssey) at 30 g ai/ha, imazamox (AC 299,263) at 20 g ai/ha and imazethapyr (Pursuit) at 50 g ai/ha were applied to peas in 1998. The plots were seeded to canola, flax and potato in 1999. Crop injury to canola, flax and potato was noted for the imazamox and the imazamox + imazethapyr treatments, however biomass (based on dry weight) and potato total and marketable yields were unaffected. Imazethapyr applied alone caused unacceptable crop injury in all crops and yields were significantly reduced in canola and potato.

Weed control in special crops

Pulse Crops — Four bean types (pinto, red kidney, pink and great northern) were evaluated for tolerance to Odyssey (1:1 mixture of imazamox + imazethapyr) applied at 0, 30 and 60 g ai/ha with Merge adjuvant at 0.5% (v/v) when the crop was in the first trifoliate leaf stage. All bean types were temporarily chlorotic after Odyssey application. Both rates of Odyssey caused crop injury resulting in significantly reduced bean yields in relation to the hand weeded check. Odyssey controlled redroot pigweed, mustard and barnyard grass.

Coriander and caraway — A weed control trial was conducted with coriander underseeded with caraway to evaluate crop tolerance to a mixture of linuron (Lorox DF) and sethoxydim (Poast) + Merge and to determine control of volunteer cereals by this mixture. Crop tolerance of both crops was excellent and coriander yields were not affected. Control of volunteer barley appeared to be reduced in the treatments where linuron and sethoxydim + Merge were tankmixed in comparison to sethoxydim + Merge applied alone.

Canary seed — Quinclorac (Accord) was evaluated in combination with difenzoquat (Avenge) and bromoxynil + MCPA (Buctril M) for the control of grassy and broadleafed weeds. Fluroxypyr + 2,4-D LV ester (Attain) and sulfosulfuron were also tested. Sulfosulfuron caused complete crop mortality, injury for the other treatments was minimal and seed yields were not affected. Quinclorac tank mixes and Attain treatments provided excellent control of redroot pigweed, lamb's-quarters and mustard. Grassy weeds were too sparse to be evaluated.

Weed control in forage seed crops

Two trials with Kentucky bluegrass were conducted in 1999. In one trial, 15 herbicide treatments were applied in 1998 when the crop was in the two-leaf stage. Crop tolerance to all treatments was excellent and seed yields were not affected in comparison to the hand weeded check. In a second trial, 17 herbicide treatments were applied to an established stand of Kentucky bluegrass for the control of broad-leaved weeds. Crop injury was noted for tralkoxydim (Achieve) and thifensulfuron methyl + tribenuron methyl (Refine Extra), both causing significantly reduced seed yields.

Weed control in fruit crops

A herbicide screening trial for weed control in black currants was conducted with the goal of submitting the best performing herbicides for minor use registration. First year results showed black currants to have excellent tolerance to both trifluralin (Treflan) and linuron (Lorox DF) at the rates tested. Lontrel was also tested but caused unacceptable crop injury.

Technology Transfer Services

Weed control recommendations were provided to growers by telephone, letter or office/farm visits, and presentations were made at producer and professional meetings. Some informal tours of the research plots were conducted for technical representatives of chemical companies.

Pest Prevention and Management Unit

Dutch Elm Disease & Arbor Day Program

J. Feddes-Calpas

Dutch elm disease program

In Alberta, Dutch elm disease (DED) pathogens (*Ophiostoma ulmi* Buis. and *Ophiostoma nova-ulmi* Brasier), native elm bark beetles (NEBB) (*Hylurgopinus rufipes),* and European elm bark beetle (SEEBB) (*Scolytus multistriatus*), are declared pests under the Provincial Agricultural Pests Act. The Federal Plant Protection Act regulates the movement of the disease.

Monitoring for the SEEBB and the NEBB is carried out throughout the province each year to determine if the beetles are present. If either beetle is found, surveillance of the disease and beetle monitoring locations is increased in that area. Sticky traps were set up in a total of 505 sites throughout Alberta. The SEEBB's have been found in low numbers in Calgary for the sixth year, in Edmonton for the fifth year, and Medicine Hat and St. Albert for the second year. New SEEBB sites for 1999 are Coutts Port of Entry and Lawland Gardens, Balzac. To date, no NEBB's have been found in the province.

Alberta has been fortunate to remain DED free for many years. However, in March 1999, one 70-year-old American elm tree (*Ulmus americana L.*) in Wainwright was confirmed to have the disease. A sample was taken from a dying elm tree on June 25, 1998. Lab cultures identified DED causing fungus, *Ophiostoma nova-ulmi* Brasier, the most virulent among the DED fungi. The culture was inspected by Dr. Tewari at the University of Alberta (U of A), and confirmed on March 31, 1999 by Professor Clive Brasier who originally described *O. nova-ulmi*. The wilted canopy in this tree increased from 35 to 75% in approximately 45 days. The tree was reported by a Society to Prevent Dutch Elm Disease (STOPDED) employee while completing an elm inventory in Wainwright.

The tree was treated as having DED, although the results were not final, was immediately removed and burnt at the Wainwright dump on July 28, 1998. Additional traps were placed throughout the municipality but no beetles were found. It is still unknown which vector was present. Samples were taken from all other suspect trees and tested. In 1999, trap locations were increased in Wainwright and surrounding communities and inspected monthly. No vectors were found and no other elm trees showed any DED symptoms. It is believed that firewood brought into the province was the source of infection.

In July of 1999, an elm inventory and inspection was done in and around Wainwright within a two mile radius. The elm trees in the town were also inspected monthly. The infected tree in Wainwright appears to be an isolated case of DED as no other trees in the town or province have been found. A total of 28 elm samples from across the province were tested for DED by Dr. Tewari at the U of A.

In March 1999, STOPDED with the help of in-kind contributions from Alberta Agriculture, Food and Rural Development (AAFRD) and larger cities, completed a province-wide elm inventory (started in March 1997) in all the cities, towns, villages and hamlets in the province. Location and condition of each elm tree were recorded.

There are a total of 219,334 elms valued at $634 million growing in Alberta's urban areas and up to 50% of tree plantings in municipal landscapes are elms. A complete elm inventory supplies basic information necessary for an effective DED prevention/management program for each municipality. The information also identifies areas where more intensive surveillance is necessary due to the number and/or condition of the elm trees.

In September, each municipality was sent their elm inventory on a CD-ROM. This CD-ROM includes a user-friendly computerized elm inventory program as well as each community's public and private elm tree inventory. Workshops were held throughout the province to enable the full use of the program and how to use it in the community DED prevention program.

To get ahead of the threat of DED, municipalities have been encouraged to use the inventory information to help with the elm sanitation which is essential and is a recommended management strategy for prevention and control. Elm trees should be pruned at least every five years, or as often as necessary to remove any dead wood.

Pruning of elm trees in Alberta must only be done between October 1 and March 31 of the following year. This is when the beetles are not active therefore avoiding any risk of them being attracted to fresh cuts. Several municipalities already have an elm pruning bylaw in place which would result in a fine if you prune an elm outside the pruning dates. It is also illegal to transport or store elm firewood. All pruned elm wood must be burned or buried to prevent the possible spread of DED.

Arbor day program

Arbor Day was celebrated on May 6 by schools in 206 municipalities across the province. This year saw a full 100,000 trees seedlings, spruce, scotch pine and lodgepole pine, supplied by AAFRD and distributed to grade 1-6 students. Cooperators for tree distribution included AAFRD, Trans Alta Utilities, and the Parks Departments in Edmonton, Calgary, Lethbridge, Red Deer, Medicine Hat, St. Albert, and Strathcona County. The seedlings were purchased from Marketland Corp., Bowden. An additional 33 municipalities were included in the Arbor Day celebrations for the first time this year.

Technology Transfer Services

Public awareness has been accomplished across the province by participating in tradeshows, articles, news media, and poster and brochure distribution to all the provincial parks and Alberta Information Centres. A DED advertisement was placed in the 1999 Alberta Campground Guide. Public information sessions were conducted featuring the STOPDED video *The Last Stand*, displays, and printed information about the disease.

Dutch Elm Disease Awareness Week was celebrated across the province from May 31 to June 4 by having the video aired on several television stations. An article published by the *Agri-News* was picked up by local papers and radio stations. Tammy Wall, a grade six student, was the winner of the 1999 DED Awareness Week poster contest which was distributed across the province.

With the progress AAFRD and STOPDED has made in the province wide DED Prevention Program, Alberta has a solid program to deal with DED if it were to appear within the province. Alberta is fortunate to have this window of opportunity to set up a prevention program, which very few areas fighting the disease had and as a result have lost millions of trees.

Meteorological Report

N.G. Seymour and T.T. Pheh

The Alberta Agriculture, Food and Rural Development's Crop Diversification Centre South (CDCS) operates two automated weather stations; one at the Centre southeast of Brooks and another at the sub-station southwest of Bow Island.

Brooks (CDCS) — Precipitation is measured with two instruments at the Brooks station. The Tipping Bucket Rain Gauge (TBRG) very accurate in reading rainfall to 0.2 mm is not reliable for recording snowfall. The Fischer-Porter Weighing Gauge (F&P) provides an accurate reading for snowfall equivalent. During the growing season of 1999, Brooks received rainfall well above the thirty year average while temperatures, except in August, were cooler.

The final spring frost of 1999 occurred on May 13 (-0.9°C). The first autumn frost was -1.2°C on September 19, giving a total of 128 frost-free days in 1999. This is higher than the 30-year average (1951-80) of 116 frost-free days (May 21 to September 15).

Table 7. 1999 Brooks (CDCS) Weather Data

	Temperatures (°C)							
	Extremes		Average				Means	
	Max	Min	Max	30 yr av	Min	30 yr av	1999	30 yr av
January	7.3	-30.2	-5.7	-6.9	-17.3	-23.6	-11.5	-12.5
February	14.9	-17.7	5.0	-2.4	-7.7	-13.9	-1.3	-8.2
March	21.6	-17.5	8.4	3.1	-6.1	-10.6	1.1	-2.7
April	26.6	-9.4	13.6	12.2	-1.6	0.7	6.0	5.1
May	31.8	-3.7	16.9	18.7	3.3	3.5	10.1	11.4
June	29.3	1.4	21.2	23.0	7.4	9.8	14.3	15.9
July	33.1	4.4	23.4	25.9	9.0	11.8	16.2	18.3
August	31.2	3.8	25.6	25.2	10.8	10.9	18.2	17.5
September	31.7	-3.8	19.8	18.9	3.7	5.8	11.8	11.6
October	24.4	-8.6	15.0	13.6	-1.5	-1.4	6.8	6.3
November	21.9	-14.5	9.3	2.1	-4.1	-13.3	2.6	-3.7
December	16.4	-17.7	6.1	-4.6	-8.0	-21.3	-1.0	-10.3
Average	24.2	-9.5	13.2	10.7	-1.0	-2.6	6.1	4.1

	Precipitation (mm)			
	1999			1961-90
	TBRG		F&P	30 yr av
January		n/a	8.8	18.4
February		n/a	2.1	11.9
March		n/a	3.8	17.0
April		35.6	25.9	26.9
May		39.8	38.5	39.1
June		115.0	103.4	65.4
July		110.2	110.2	38.0
August		47.2	48.3	36.3
September		2.4	2.6	38.8
October		5.2	4.1	15.8
November		n/a	6.1	14.9
December		n/a	6.2	18.4
Average	Tot.	n/a	360.0	341

Bow Island (Sub-station) — The last recorded frost was -0.9°C on May 13 and the first autumn frost (-1.4°C) occurred on September 27, for a total of 136 frost-free days in 1999, greater than the 30-year average (1951-80) growing season at Bow Island of 125 days (May 17 to September 20).

It is important to note that precipitation is only measured with a tipping Bucket Rain Gage which is unreliable during the winter months.

Table 8. 1999 Bow Island Weather Data

	Temperatures (°C)							
	Extremes		Average				Means	
	Max	Min	Max	30 yr av	Min	30 yr av	1999	30 yr av
January	6.8	-27.6	-3.1	-5.2	-14.8	-15.9	-8.9	-10.6
February	14.5	-11.1	6.1	-0.9	-4.8	-11.7	0.7	-6.3
March	22.2	-15.1	9.2	4.7	-5.1	-6.6	2.0	-0.9
April	23.3	-10.0	12.6	12.5	-2.1	0.2	5.3	6.6
May	30.8	-3.7	16.6	19.2	4.0	5.5	10.3	12.4
June	29.4	3.1	20.7	24.4	7.9	10.7	14.3	17.6
July	33.4	4.3	23.5	27.6	8.8	12.1	16.2	19.7
August	32.3	4.9	25.7	27.1	11.0	11.9	18.3	19.6
September	30.3	-4.7	18.4	20.2	3.8	5.6	11.1	12.9
October	23.5	-7.2	14.6	15.0	0.8	0.5	7.7	7.6
November*	33.4	-8.0	11.6	4.7	-0.9	-6.6	5.4	-1.0
December*	14.8	-16.9	5.3	-2.8	-7.1	-13.0	-0.9	-7.9
Average	24.6	-7.7	13.4	12.2	0.1	-0.6	6.8	5.8

* Data for November and December may be inaccurate because the station was not functioning from November 24 to December 5 due to battery failure.

	Precipitation (mm)		
	1999		1961-90
	TBRG		30 yr av
January	7.1		18.6
February	0.0		11.3
March	18.0		13.1
April	37.3		34.2
May	37.8		44.9
June	80.5		69.8
July	18.8		30.9
August	39.4		32.4
September	8.1		30.4
October	11.2		12.3
November*	4.3		12.8
December*	2.3		19.0
Average	Tot.	265	330

* Data for November and December may be inaccurate because the station was not functioning from November 24 to December 5 due to battery failure.

Table 9. 1999 Edmonton (CDCN) Weather Data

	Temperatures °C					
	Extremes		Average		Means	
	Max	Min	Max	Min	1999	30 yrs
January	5.97	-38.46	-8.39	-21.69	-15.04	-10.10
February	8.66	-27.36	-0.91	-15.48	-8.20	-9.80
March	10.34	-23.36	1.56	-8.50	-3.47	-3.30
April	23.76	-6.33	11.50	-0.33	5.59	5.00
May	28.65	-3.1	15.36	2.78	9.07	11.05
June	27.22	3.42	20.04	7.74	13.89	14.75
July	28.78	4.43	21.11	9.31	15.21	16.00
August	29.74	2.84	23.51	9.84	16.68	15.40
September	26.87	-4.77	17.69	3.90	10.80	11.00
October	22.47	-5.01	11.89	-0.50	5.70	4.50
November	11.59	-20.3	3.26	-7.24	-1.99	-5.30
December	14.36	-29.45	1.82	-9.60	-3.89	-10.10
Averages	19.88	-12.29	9.87	-2.48	3.70	3.26

	Precipitation			
	Snow (cm)		Rain (mm)	
	1999	Ave.	1999	Ave.
January	55.9	20.3	0	2.6
February	5.4	16.5	0	3.5
March	5.3	12.9	8.5	2.2
April	2.8	11.7	23.1	12.4
May	0	10.9	71.0	46.8
June	0	0	36.0	91.4
July	0	0	92.5	91.6
August	0	4.0	78.6	73.3
September	0	2.5	6.8	42.6
October	2.0	6.5	8.1	11.5
November	4.8	13.5	7.5	3.7
December	7.4	21.4	5.1	2.7
Total	83.6	120.2	337.2	384.3

Heat Units* at CDCN calculated from last to first killing frost.**

May	110.68
June	266.63
July	316.46
August	361.94
September	183.35
Total	1239.06

Last killing frost — May 11, 1999

First killing frost — September 27, 1999

* Calculation based on 5°C Base temperature.

** Killing frost is taken as minus 2°C.

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Mirza, M., M. Younus, W. Chen, Y. Hoyano and R.A. Currie. 1999. Echinacea—from germination to greenhouse production. Fourth Annual Commercial Herb growing Conference and Herb Research Day. Uxbridge, ON. October 22-24.

Mirza, M. 1999. Understanding pH from tree seedling perspective. Forest Nursery/Silvicultural Practices/Technology Course, Module VIII. Northern Forestry Centre. Edmonton, AB. December 13-14.

Pruski, K. 1999. Pest Management Projects and Horticulture Programs at AAFRD/CDC North. Atlantic Horticulture Research Centre, AAFC, Kentville, Nova Scotia. Mar. 15.

Pruski, K. 1999. Entomology and Micropopagation Program at CDC N. Nova Scotia Agricultural College, Truro, NS. March 16.

Presentations at Industry Meetings

Bains, P.S. 1999. Diseases of Echinacea. Echinacea Production Workshop. Edmonton, AB. March 17.

Bains, P.S. 1999. Diseases That Can Destroy Your Crop. FGSA Saskatoon and Chokecherry Production Workshop. Edmonton, AB. March 19-20.

Bains, P.S., H.S. Bennypaul, and R.J. Howard. 1999. Identification of fungicides for control of various saskatoon diseases: survey of saskatoon diseases and isolation of disease causing pathogens. Alberta Horticultural Congress. Edmonton, AB. Nov. 11-13.

Bandara, M. and C. Wildschut. 1999. CDCS Field Day for growers from Swift Current, SK. June 22.

Bandara, M. and L. Ost. 1999. Special Crops Field Day. Standard, AB. August 12.

Bandara, M. and E. Russell. 1999. Organic Herb Production Field Day. Pincher Creek, AB. August 25.

Bandara, M. and E. Russell. 1999. Herb & Medicinal Plant Production Field Day. Olds College Applied Degree Students. August 26.

Bandara, M. and E. Russell. 1999. Factors Affecting Sustainability of Organic Herb Production. Meeting with Alpine Herb Association. December 3.

Blade, S.F. 1999. Keynote address: Varietal development of special crops in Alberta. Canadian Special Crops Association 13th Annual Convention. Edmonton, AB. July 6.

Blade, S.F. 1999. Breeding superior field pea cultivars for western Canada. AgriFutures 1999 Conference Proceedings (Appendix 1:20-24). Red Deer, AB. February 5.

Blade, S.F. 1999. Current aspects of industrial hemp production in Canada. Opportunities in Industrial Hemp Production Conference. Annapolis Valley College, Nova Scotia. April 19.

Blade, S.F. 1999. What's New in Special Crops? "Small Can be Beautiful Conference: Carving a Niche in Alternate Crops" Proceedings (pages 16-29). Brooks, AB. March 25.

Blade, S.F. 1999. New Crops for Alberta. Parkland Fertilizer crops day. Wetaskiwin, AB.

Calpas, J.T. 1999. Supporting greenhouse research. Red Hat Co-op annual meeting. March 4.

Calpas, J.T. 1999. "Greenhouse Crops". Small can be beautiful: Carving a niche in alternative crops. Conference. Brooks, AB. March 25.

Calpas, J.T. 1999. History of the Red Hat Co-op. Red Hat Co-op grand opening and industry seminar. Redcliff, AB. September 22.

Calpas, J.T. 1999. Greenhouse crop diversification opportunities. Red Hat Co-op grand opening and industry seminar. Redcliff, AB. September 22.

Calpas, J.T. 1999. Update of greenhouse crops research. Alberta Horticultural Congress. Edmonton, AB. November 12.

Chang, K.F. 1999. Diseases of field pea, chickpea, and lentil occurring in southern Alberta and their control measures. Soil and Crop Diagnostic School, Lethbridge Research Centre. Lethbridge, AB. June 30, July 5 and 7.

Chang, K.F. 1999. Diseases of medicinal herbs and their controls under organic farming systems. Up Your Organics Conference, Northern Lights Herbs Inc. Prince Albert, SK. Feb. 5-6.

Chang, K.F., S.F. Hwang, R.J. Howard and S.F. Blade. 1999. Diseases of ginseng and echinacea occurring in Alberta in 1998. Alberta Ginseng Association Annual Meeting. Red Deer, AB. March 6.

Choban, B. 1999. Opportunities in vegetable production. AgVenture Workshop. Brooks, AB. March.

Choban, B. 1999. Developing your potential—production and direct marketing tips. Seminar. Alberta Market Gardeners Association. Edmonton, AB. March.

Choban, B. 1999. Beginner vegetable production. Alberta Agriculture Course. CDCN, Edmonton, AB. April.

Choban, B. 1999. Vegetable research trials. Field Day, CDCN. Edmonton, AB. July 28.

Choban, B. 1999. "Building Bridges". University of Alberta. Edmonton, AB. Sept. 16

Choban, B. 1999. Increasing farm income through marketing the farm. Alberta Horticultural Congress. Edmonton, AB. Nov. 12.

Choban, B. 1999. Tool box—market garden source list. Alberta Horticultural Congress. Edmonton, AB. Nov. 13.

Choban, B., P. Ragan. 1999. Vegetable production workshop. Edmonton, AB. Dec. 7.

Choban, B., P. Ragan. 1999. Vegetable production workshop. Stettler, AB. Dec. 8.

Choban, B., P. Ragan. 1999. Vegetable production workshop. Lethbridge, AB. Dec. 10

Colter, D. 1999. Honey bees and pesticides. Super Canola Meetings. Fort Vermilion, Grimshaw, Grande Prairie, AB. March 8, 9, 11,12.

Colter, D. 1999. Varroa and tracheal mite detection and control demonstration. Beekeepers Field Day, AAFC. Beaverlodge, AB. June 25.

Colter, D. 1999. Small hive beetle update. Alberta Beekeepers' Association Annual General Meeting. Edmonton, AB. November 2.

Colter, D. 1999. Presentation on parasitic mite management. Peace Region Pest Management & Research Meeting. Peace River, AB. December 6.

Esau, R. 1999. Weed control in potato crops. Potato Workshop. Taber, AB. Feb. 16.

Feddes-Calpas, J. 1999. Dutch elm disease display. Provost Trade Show. Provost, AB. April 16.

Feddes-Calpas, J. 1999. Dutch elm disease display. Brooks Trade Show. Brooks, AB. April 17.

Feddes-Calpas, J. 1999. Dutch elm disease and purple loose strife display. Prairie West Horticulture Trade Show. Edmonton, AB. November 11-13.

Feddes-Calpas, J. 1999. AAFRD Dutch elm disease program update. Society to Prevent Dutch Elm Disease (STOPDED) meetings in Alberta. Lethbridge-January 20. Calgary-April 21. Edmonton-July 21. Brooks-October 20.

Feddes-Calpas, J. and V. Mumby. 1999. DED Prevention and Inventory Computer Workshops in Alberta. Medicine Hat-Sept 9. Lethbridge-Sept 10. Edmonton-Sept 20-21.

Hausher, L.G. 1999. Strawberry/raspberry/saskatoon production and marketing topics . Commercial Berry Production School. Red Deer, AB. January.

Hausher, L.G. 1999. Alberta fruit crop production. Small Can Be Beautiful Conference. Brooks, AB. March.

Hausher, L.G. 1999. Black currant research/industry overview. Black Currant Information Day. Brooks, AB. July.

Hausher, L.G. 1999. Black currant/gooseberry research trials. Alberta Horticultural Congress. Edmonton, AB. November.

Hausher, L.G. 1999. Alberta saskatoon industry update. Western Canadian Saskatoon Pest Management Working Group. Edmonton, AB. November.

Holley, J.D. 1999. Efficacy of the new fungicide Maxim in controlling levels of fusarium dry-rot, helminthosporium silver scurf, and rhizoctonia canker and black scurf disease on stored potato. Novarits Symposium. Toronto, ON. March 13-16.

Holley, J.D. 1999. The phenomenon of fungicide resistance, how it develops and how it can be accurately identified. Fall Meeting of the Irrigated Alfalfa Seed Growers Association (IASGA).

Howard, R., B. Vladicka. 1999. The horticulture industry in Alberta. Ag Lenders Workshop. Olds College, Olds, AB. June 2.

McKenzie, R.C. 1999. Tissue nutrient levels of potatoes receiving phosphorus and compost applications. Alberta Potato Growers summer meeting. Vauxhall, AB. July.

McKenzie, R.C. 1999. Fertility needs for irrigated potatoes. Alberta Potato Growers breakfast meeting. Taber, AB. March.

McKenzie, R.C. 1999. Soil fertility and soil salinity of irrigated crops. Lethbridge Agronomy Field School. June & July.

Mirza, M. 1999. Production of echinacea and other medicinal plants in greenhouses. Grand Prairie Horticultural Society. February 16.

Mirza, M. 1999. From bucket chemistry to computerized fertilizer systems. Alberta Horticultural Congress. Edmonton, AB. November 12.

Mirza, M. 1999. Production of medicinal plants in greenhouses. Crop Diversification Workshop. Camrose, AB. February 24.

Mirza, M., M. Younus and W. Chen. 1999. Echinacea production workshop. CDCN, Edmonton, AB. March 17.

Mirza, M. 1999. Fertilizer management of bedding plants. Bedding plants workshop, High Q Greenhouses. Morinville, AB. February 11.

Mirza, M., M. Younus and W. Chen. 1999. A summary of research results and production of lettuce in greenhouses. CDCN Open House. Edmonton, AB. April 7.

Mirza, M. 1999. Fertilizer management of bedding plants. Bedding Plants Workshop. Qualtec Greenhouses. Eckville, AB. April 21.

Mirza, M. 1999. Production of Echinacea plugs. Echinacea workshop. Black Diamond, AB. June 17.

Mirza, M. 1999. Production of lettuce under greenhouse conditions. Southern Greenhouse Growers Association. Texas, USA. July 15-17.

Mirza, M. 1999. Guidelines for the production of poinsettias. CDCN Poinsettia production workshop. Edmonton, AB. July 28.

Mirza, M. 1999. Opportunities for crop diversification. Red-Hat Co-op inagural seminar. Redcliff, AB. September 22.

Mirza, M. 1999. Guidelines for the production of poinsettias. Alberta Greenhouse Growers Association Open House. Salisbury Greenhouses, Sherwood Park, AB. Oct 6.

Mirza, M. 1999. Guidelines for the production of poinsettias. Alberta Greenhouse Growers Association Open House at Balzac Greenhouses and Garden Centre. Balzac, AB. October 13.

Mirza, M. 1999. Alberta greenhouse crops industry in the next millennium. University of Alberta, AFNS, Plant Science guest lecture. October 20.

Mirza, M. 1999. Controlled Environment Cropping Systems. University of Alberta, AFNS. Plant Science guest lecture. November 16.

Murray, C.L. 1999. Nursery Research in Alberta Trials. Alberta Horticultural Congress, Edmonton, AB. November.

Najda, H. 1999. Project design— obtaining the best results. Applied Research Association Conference. Red Deer, AB. November 9-10.

Najda, H. and A. Kruger. 1999. Companion cropping in tall fescue and perennial ryegrass. Canadian Forage Seed Conference. Winnipeg, MB. January 24-27.

Pruski, K. 1999. Principles of Plant Tissue Culture; Growth Regulators in Tissue Culture Propagation; Economics of Tissue Culture. CDCN Tissue Culture Course. Edmonton, AB. January 27-28.

Pruski, K. 1999. Chemical Insect Control in Greenhouse Vegetables. Pik-a-Pak meeting. Lacombe, AB. February 3.

Pruski, K. 1999. Chemical Insect Control in Bedding Plant Greenhouses. Alberta Greenhouse Growers Association Workshop, HQ Greenhouses. Morinville, AB. Mar 11.

Pruski, K. 1999. Insect Identification Workshop at the Berry School. Fruit Growers Society of Alberta and Alberta Market Gardeners Association. Edmonton, AB. March 19-20.

Pruski, K. 1999. Pest Management in Greenhouse Ornamental Crops. Alberta Greenhouse Growers Association Workshop, Rocky Mountain House Greenhouses. Rocky Mountain House, AB. April 21.

Russell, E. and M. Bandara. 1999. CDCS Herb Openhouse. Brooks, AB. August 12.

Seymour, N.G. 1999. Monitoring and overwintering container grown nursery stock with data-loggers—manned booth. PID Conference Tech Fair. Red Deer, AB. Mar 2-3.

Seymour, N.G. 1999. Practicum presentation for completion of Bachelor of Applied Horticulture Technology degree. Olds College, Olds, AB. March 19.

Tuckey, K. 1999. Beekeeping and Pesticides. Alberta Aerial Applicators Association Board Meeting. Wetaskiwin, AB. February 11.

Tuckey, K. 1999. The Finances of a Beekeeping Operation. Ag Lenders Conference. Olds, AB. June 2.

Tuckey, K. 1999. Alberta Update. Beekeepers Field Day, AAFC. Beaverlodge, AB. June 25.

Tuckey, K. 1999. Basis For the New Millennium. Alberta Beekeepers' Association Annual General Meeting. Edmonton, AB. November 1.

Tuckey, K. 1999. Basis For the New Millennium. Edmonton and District Beekeepers' Association. Edmonton, AB. November 18.

Vladicka, B. 1999. Marketing basics. OCIA workshop. Westlock, AB. January 23.

Vladicka, B. 1999. To market, to market, the basics of organics. Horticulture Diversification Conference. Camrose, AB. February 24.

Vladicka, B. 1999. On-farm food safety initiative. Fruit Growers of Alberta Berry School. Edmonton, AB. March 19.

Vladicka, B. 1999. Approaches to direct marketing. Small Can Be Beautiful Workshop. Brooks, AB. March 25.

Wildschut, C. and M. Bandara. 1999. Research Update. Annual Meeting of the Alberta Pulse Growers Commission-Zone 1. December 8.

Media Interviews

Blade, S.F. 1999. Call of the Land (several topics: Western Canadian Medicinal and Aromatic Plants Conference, new field pea cultivars, research on low-THC hemp, the Alberta New Crops Network, etc.) Radio.

Blade, S.F. 1999. Mid-Day Express, CBC Provincial radio show. Radio. April 29.

Blade, S.F. 1999. This Business of Farming. RD-TV. The release of the Herb and Spice Production and Planning CD-ROM and the Pulse Crops of Alberta (new crop production manual). Television. October.

Blade, S.F. 1999. The Calgary Herald. The Business of Hemp. Newspaper. November 7.

Blade, S.F. and K. Alde. 1999. Hemp-A First-time Grower's Experience. Top Crop Manager. Magazine. February. pp. 25-29.

Choban, B. 1999. Promotion of Alberta's Fresh Vegetable Industry and Consumption of Fresh Fruits and Vegetables. Fall Harvest Festival—Vegetables Sales. Northern Alberta Produce Marketing Association. CFRN TV. Edmonton, AB. Aug. 29

Choban, B. 1999. Promotion of Alberta's Fresh Vegetable Industry. Fall Harvest Festival— Dinner. Northern Alberta Produce Marketing Association. TV. Edmonton, AB. Sept. 23.

Feddes-Calpas, J. 1999. Wainwright Dutch Elm Disease Infected Elm. Wainwright Press Release. Wainwright, AB. May 4.

Feddes-Calpas, J. 1999. Wainwright Dutch Elm Disease Infected Elm. CBC-Edmonton Radio Station. May 5.

Feddes-Calpas, J. 1999. Wainwright Dutch Elm Disease Infected Elm. CBC-Calgary Radio Station. May 5.

Feddes-Calpas, J. 1999. Dutch Elm Disease. Call of the Lands, AAFRD, Edmonton, AB. June 8.

Feddes-Calpas, J. 1999. Dutch Elm Disease. Key 83 Radio Station, Wainwright, AB. May 4, June 3, July 7.

Mirza, M. 1999. Greenhouse Cropping in Alberta. CHQT radio station. Edmonton, AB. January 17.

Vladicka, B. On-Farm Food Safety. Call of the Land, AAFRD, Oct 13.

Staff List

Food Processing

D.R. Driedger, M.Sc. ..... Food Science Technology, CDCS
L.R.J. Dowdell, B.Sc., M.Sc. ..... Food Science Technology, CDCS

Forage Unit

H.G. Najda, B.Sc., M.Sc., P.Ag. ..... CDCS
D. Braaten ..... (TS), CDCS
A. Kruger, Dipl. Ag. ..... CDCS

Horticulture Unit

R.J. Howard, B.S.A., M.Sc., Ph.D., P.Ag. ..... Director & Horticulture Unit Leader, CDCS
K. Andrew, B.Sc. ..... Seed Potato Program, CDCN
P. Bains, B.Sc., M.Sc., Ph.D. ..... Plant Pathology, CDCN
H. Bennypaul, B.Sc.,M.Sc. ..... Plant Pathology (TS), CDCN
J. Calpas, B.Sc. (Ag), M.Sc., P.Ag. ..... Greenhouse Crops, CDCS
W. Chen, B.Sc. ..... Greenhouse Crops (TS), CDCN
B. Choban, B.Sc. ..... Vegetable Crops, CDCN
P. Coté, Dipl. Grnhs. Tech. ..... Greenhouse Crops, CDCS
S. Dalpé, B.Sc. Forestry ..... Fruit Crops, CDCS
S. Demers Collins, B.Sc. ..... Farmers' Market Administrator, CDCN
P. Duplessis, B.Sc. (Ag.), M.Sc. ..... Seed Potato Program, CDCN
C. Feth, Dipl. Hort., B.S.A. ..... Potato Agronomy Program, CDCS
N. Geschke, Dipl. Bio. Sci. ..... Entomology Program, CDCN
S. Graham, B.Sc. (Botany), Dipl. Grhs Mngt ..... Greenhouse Crops (TS), CDCS
L. G. Hausher, B.Sc. (Ag.) ..... Fruit Crops, CDCS
M. Konschuh, B.Sc., Ph.D. ..... Greenhouse Crops (TS), CDCS
T. Lewis, B.Sc. (Ag.) ..... Seed Potato Program, CDCN
C. McIsaac ..... Vegetable Crops, CDCN
M. Mirza, B.Sc. (Hons.), M.Sc., Ph.D., Dh.t., P.Ag. ..... Greenhouse Crops, CDCN
C. L. Murray, B.Sc. (Ag.), Ph.D. ..... Nursery Crops, CDCS
T.T. Pheh, Dipl. Ag. ..... Nursery Crops, CDCN
K. Pruski, B.Sc., M.Sc., P.Ag. ..... Entomology, CDCN
P. Ragan, B.Sc (Ag.), M.Sc., Ph.D. ..... Vegetable Crops, CDCS
H. Sagert ..... Vegetable Crops (TS), CDCS
C. A. Schaupmeyer, B.Sc. (Ag.), M.Sc., P.Ag. ..... Potato Agronomy Program, CDCS
N. G. Seymour, Dipl. Hort. ..... Nursery Crops, CDCS
B. Vladicka, P.Ag. ..... Horticulture Development Officer, CDCN
M. Younus, B.Sc., M.Sc. ..... Greenhouse Crops, CDCN
M. Yu, Dipl. Biotechnology ..... Plant Pathology, CDCN

Arrivals

K. Andrew, B.Sc. ..... Seed Potato Program, CDCN
N. Geschke, Dipl. Bio. Sci. ..... Entomology Program, CDCN

Departures

T.R. Krahn, B.Sc., (Ag.), M.Sc., P.Ag. ..... Director & Horticulture Unit Leader, CDCS—March 1999

Education Leave

W. Johnson, Dipl. Hort. ..... Vegetable Crops, CDCS—September 1999
J. Motta, B.Sc. (Ag.) ..... Entomology, CDCN

New Crop Development Unit

S.F. Blade, B.Sc., M.Sc., Ph.D., P.Ag.	Director & New Crop Development Unit Leader, CDCN
M. Bandara, B.Sc., Ph.D.	Special Crops, CDCS
C.L. Bandura	Plant Pathology (TS), CDCS
M.A. Briant, Dipl. Hort.	Plant Pathology, CDCS
D.A. Burke, B.Sc.	Plant Pathology (TS), CDCS
K.F. Chang, B.Sc., M.Sc., Ph.D.	Plant Pathology, CDCS
N.F. Clark, Dipl. R.R.T.	Special Crops, CDCN
D. Colter, B.Sc.	Apiculture, Falher
L. Hingley, B.Sc.	Soil & Water Agronomy , CDCS
J.D. Holley, B.Sc., M.Sc., Ph.D.	Post-Harvest Technology, CDCS
S.P. Huggons	Plant Pathology (TS), CDCS
B.E. Kruger, Dipl. Agr.	Weed Science, CDCS
S.I. Lisowski, Dipl. R.M.T.	Post-Harvest Technology (TS), CDCS
L. Maskewich, B.Sc.	Special Crops, CDCN
R.C. McKenzie, B.S.A., M.Sc., Ph.D., P.Ag.	Soil and Water Agronomy, CDCS
L.M. Ost, Dipl. Ag.	Special Crops, CDCS
E.A. Russell, Dipl. Hort.	Special Crops, CDCS
T. Schick, B.Sc.	Plant Pathology (TS), CDCS
T. Simo	Special Crops (TS), CDCS
S. Sims, Dipl. Land Agent	Plant Pathology (TS), CDCS
K. Tuckey, B.S.A., B.Ed.	Apiculture, CDCN
J. Webber	Special Crops (P/PT), CDCS
C.J. Wildschut, Dipl. Hort.	Special Crops, CDCS

Arrivals

M. Bandara, B.Sc., Ph.D.	Special Crops, CDCS
L. Maskewich, B.Sc.	Special Crops, CDCN

Departures

R. Esau, B.S.A., M.Sc., P.Ag.	Weed Science, CDCS
R.J. Park, B.Sc. Ag. Sci.	Special Crops, Lacombe

Educational Leave

S.A. Woods, B.Sc., M.Sc.	Soil and Water Agronomy, CDCS—September 1999

Pest Prevention and Management Unit

J. Feddes-Calpas, Dipl. Hort., Journeyman Landscape Gardener	Dutch Elm Disease, CDCS

Farm, Shop and Site Operations

G. Dames	Welder, CDCN
G. Feth, Dipl. Hort.	Grounds Technologist, CDCS
G. Hooke, Journeyman Landscape Gardener	Chemical Applicator & Gardener, CDCN
C. Mackenzie, Dipl. Hort.	Grounds (TS), CDCS
B. Merkl	Mechanic, CDCS
S. Milne	Irrigation Technician, CDCN
B. Petherbridge	Maintenance Service Worker, CDCN
R. Williams	Senior Mechanic, CDCS
W. Wise	Farm Manager, CDCS

Departures

N. Baronasky	Lab/Farm Assistant, CDCN

Administrative Support Staff

S.J. Barkley, Dipl. Hort.	Information Officer/Librarian, CDCS
S.C. Day	Administrative Support (P/PT), CDCS
H. Ellis	Administrative Officer, CDCS
P. Fulton	Administrative Support, CDCN
L. I. Hansen	Officer Manager, CDCN
B.A. Humphreys	Receptionist/Timekeeper, CDCS
A. Moeller	Accountant, CDCS
C. Moore	Administrative Support, CDCN
V. Noel	Courier, CDCN
J.P. Petersen	Administrative Support/Human Resources, CDCS
C. Pugh	Courier (TS), CDCS
M. Tanigami-Bunney	Administrative Support, CDCS